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TRANSACTIONS
Kansas Academy of Science.

VOL. XI.

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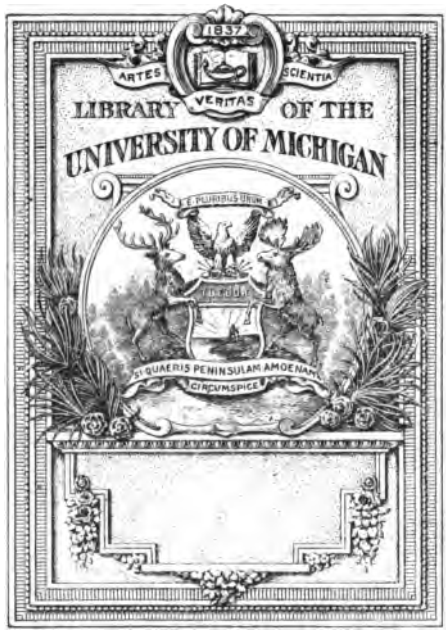
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TRANSACTIONS

OF THE

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TWENTIETH AND TWENTY-FIRST ANNUAL MEETINGS

OF THE

KANSAS ACADEMY OF SCIENCE.

COMPLIMENTS OF THE

Kansas Academy of Science.

PLEASE ACKNOWLEDGE RECEIPT.

B. B. SMYTH, Librarian.
TOPEKA, KANSAS.

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1889.

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THE TWENTIETH ANNUAL MEETING.

TRANSACTIONS.

THE Kansas Academy of Science met in its twentieth annual session, at Topeka, in Representative Hall, on the afternoon of the 26th, and continued in session through the 27th and 28th of October, 1887. The following extracts from the proceedings are deemed of public interest.

Section 3 of the Constitution of the Academy was amended by the addition, to the sentence relating to the annual memberships, of the following: "but the Secretary and Treasurer of the Academy shall be exempt from the payment of dues during the years of their service."

The announcement by the Smithsonian Institution of the death of Professor Spencer Fullerton Baird, late Secretary of that Institution, was read, and in connection therewith the following resolution was adopted:

"*Whereas*, Official information has been received of the death of Spencer Fullerton Baird, LL. D., the Secretary of the Smithsonian Institution and Director of the National Museum:

"*Resolved*, That we, the officers and members of the Kansas Academy of Science, hereby express our sense of the great loss sustained by the Nation in the death of this eminent naturalist. We gratefully acknowledge the great value of his personal achievements in scientific pursuits, and the still greater value of the stimulus afforded by him to thousands of younger students of nature in all parts of the land. His untiring and unselfish energy will ever command the admiration and increase the activity of the members of this Academy.

"*Resolved*, That the Secretary of this Academy be instructed to forward a copy of these resolutions to Professor S. P. Langley, Acting Secretary of the Smithsonian Institution."

A committee, appointed at a previous meeting to collect for preservation in the library of the Academy the photographic portraits of members, exhibited twenty-nine portraits, mostly of older members, some of whom are now dead, or removed from the State.

Officers for the ensuing year were elected as follows: President, J. R. Mead; Vice Presidents, E. H. S. Bailey, and T. H. Dinsmore, Jr.; Secretary, E. A. Popenoe; Treasurer, I. D. Graham; Librarian, B. B. Smyth; Curators, A. H. Thompson, N. S. Goss, H. W. Birchmore, Robert Hay, and E. A. Kilian. The names of seventeen persons were added to the roll of active members, and two persons resigned their membership.

The evening sessions were occupied: the first, by the address of the retiring President, Rev. John D. Parker, U. S. A., upon "Progress in Astronomy;" the second, by the lecture of Professor Lucien I. Blake, of the University of Kansas, upon "Practical Electricity and the Laws of Energy;" and the third, by the address of Chancellor H. W. Everest, of Garfield University, upon "The Utilization of Mental Power." At other sessions were presented among others the following papers:

HORIZON OF THE DACOTAH LIGNITE.

BY PROF. ROBERT HAY, JUNCTION CITY.

In various parts of middle Kansas a poor quality of coal has been in use for many years. It has been found at its outcrop, and worked by tunnels or drifts. It has also been worked by shafts in several districts. These shafts are nowhere very

deep; fifty and sixty feet being extreme depths. These beds of so-called coal are really lignite, woody fiber being observable in nearly every specimen. The seams vary from two to twenty-eight or thirty inches thick. They have various qualities, some approaching in texture and value the true coal of the eastern part of the State, but the greater part is much inferior, yielding much ash after combustion. Some is little better than carbonaceous shale, which would yield gas or oil by distillation. The localities where lignite of a usable quality is obtained in workable veins of ten inches and upwards are limited in extent, but are widely distributed, in Russell, Ellsworth, Lincoln, Mitchell and Republic counties. The carbonaceous shales have have been found as far south as Barber county and as far west as Hodgeman and Hamilton counties.

All these seams are contained in rocks of the Lower Cretaceous period. They belong to the same series of strata that contain the remarkable dicotyledonous leaves for which Middle Kansas has become famous. This is the Dacotah Group.

Years ago Prof. Mudge suggested that the lignite beds of several of these counties were probably of the same horizon. Three years ago the present writer in a paper read to the Academy suggested the desirability of verifying or otherwise determining this conclusion. A recent paper by Prof. St. John indicates that he thinks of the veins of the various localities as constituting one horizon, though he has not given its position. We are not aware of anyone who has defined this horizon.

Within the last three years, and notably within the last twelve months, the writer has made numerous excursions into the regions where the lignite is developed; some journeys being made specially to examine its outcrop and find its horizon. The results are of the most definite kind, and it is probable that their publication will be of economic value.

The Dacotah sandstones are seen resting on Permian (Permo-Carboniferous) formations near the Little Blue River at the north line of the State. The contact of these groups is seen at various other points in an irregular curve extending through Clay, Dickinson, Saline and McPherson counties to the southwest, but hidden by superficial deposits on the high prairie and in the Arkansas valley. Near this easterly boundary of the Cretaceous rocks there has been no important discovery of lignite. The lignite deposits in Republic, Jewell, Lincoln, Ellsworth and Russell counties are from thirty to fifty miles from the eastern Cretaceous frontier. Another series of rocks is becoming manifest in the topography of the country. The hill-tops and sides show level ledges of limestone from three to thirty inches thick. In some regions—*e. g.*, in mid-Lincoln county—there are five of these ledges separated by layers of limy shale. Some soft and friable, some slaty and hard. These limestones and their intercalated shales constitute the Fort Benton Group, and lie above the sandstones and colored shales of the Dacotah. It is within sight of these Benton limestones and within a short distance vertically below them that the seams of lignite occur. In one or two instances the same seam is apparently continuous for several miles. Besides this, further to the south in the northwest corner of Barber county, and in parts of Hodgeman and Hamilton counties, a black lignitic shale is found in persistent beds of about the same thickness as the main seams of the lignite in the other counties. These also are in the same relation to so-called magnesian limestone ledges of the Benton. In the southwest there are large areas covered by superficial deposits—the two tertiary formations and more recent gravels and clays. It is quite possible that in some of these areas the lignitic horizon may be not far from the surface, and instead of the shale may yield a usable variety of lignite coal.

There is no doubt that the lignites and carbonaceous shales are practically at one level. They form an horizon very nearly at the top of the Dacotah Group. In no

case is the main seam fifty feet below the base of the Benton, and it may always be relied upon, when present, within one hundred feet below the lowest Benton ledges of limestone. In some cases the lignite is within twenty or thirty feet of Benton limestones, but usually the shale over the coal gradually loses its carbonaceous and acquires calcareous qualities upwards for forty or fifty feet before a limestone ledge is fully developed. In a few cases, notably on the Smoky river and Coal creek, southwest of Wilson, a ledge of sandstone from 20 to 24 inches thick is developed over the main lignite seam. But even here other thin seams of lignite occur above this sandstone ledge, and the inclosing shales shade upward into the Benton.

The Benton limestones have a decided faunal character (*Inoceramus problematicus*, Belemnites and Nautilus being characteristic), and the slaty shales show this sometimes before the limestones are reached. In places the highest (the two feet above mentioned) sandstone ledge has the characteristic Dacotah leaves. Salix has been found in this ledge on Saw-Log creek in Hodgeman county. There is a shell bed over the lignite in Barber county that appears to belong to the Benton, but a shell bed in a similar position in Hamilton county and one in Lincoln county appear to belong to the Dacotah by lithologic as well as paleontological characters.

It is certain, then, that this lignitic horizon is in the highest part of the Dacotah Group. As to its vegetable origin, we regard it as altogether belonging to the Dacotah; but it would appear as if the sinking of the land areas at this period became more rapid, and that the waters soon became the Benton seas that overflowed the old Dacotah forests, and through sandy and carbonaceous shales shaded off the Dacotah formations into limestones of the Benton. The Benton ledges lie so horizontal, and form such a marked feature of the topography of that region, that they are the best guides to the position of the lignitic horizon. Find the lowest of these ledges, and the lignite, *if present*, will be found within one hundred vertical feet below it.

The elevations between the valleys of the rivers rise from two to three hundred feet above the bed of the streams, and in Lincoln, Ellsworth, Mitchell and Republic counties the lowest ledges of the Benton show high up on the slopes, a greater thickness of this group being developed upward as we go west. In the valleys, the lower elevations have rounder and smoother outlines, being formed upon the sandstones and shales of the Dacotah, flanked by the more superficial deposits. In places the sandstones of the Dacotah are weathered into fantastic forms of caps, pulpits and pinnacles, but the general outline of the low hills is smooth and round. As we go up the valley of the Saline the upper, massive sandstone of the Dacotah approaches more nearly the bed of the stream, and between it and the Benton is situate the lignite horizon. Erosion has cut out the lignite from any place in the main valley in Saline and Lincoln counties. It has a very slight development some four or five miles from the Lincoln county line, where the valley is much narrower, in Russell county. It is far back up the valleys of the tributary creeks, where there is a considerable thickness of overlying Benton, that the lignite is developed in Lincoln county. The principal mines are located on branches of Spilman creek in the northwest, and on the headwaters of East Elkhorn in the south of that county, and over the line in Ellsworth county. At one of the shaft mines on Spilman creek the bed of coal averages two feet thick, and has above and below it from one to two feet of a stiff carbonaceous clay shale—"draw clay," as the miners call it. This is overlain and underlain by a yellowish-white sandstone, soft and friable, the line of contact of the sandstone and clay being sharp and well marked. This shaft is 57 feet to the coal. In the Spilman creek mines the coal (lignite) is said to pinch out into the hill. This would suggest a thickening of the seam, and probably of the shales and other soft beds, towards the valleys by virtue of the removal of pressure by erosion.

This fact is not yet verified sufficiently, but it is in accordance with correct theory. It is a negative fact in favor of this, that so far coal (lignite) has not been found (or only slight traces of it) in the borings that have been made from the levels of the high prairie through the Benton to the Dacotah, as in the artesian boring at Russell city.

If the Dacotah period was characterized by a shallow sea with sandbars and low islands and peninsulas, with these sub-aërial parts clothed with forest, and if the total deposit does not exceed five hundred feet in thickness, as Prof. Mudge gives, and as is very probable,* it would not be expected that carbonaceous deposits would be sufficient to give a bed of coal in the earlier half of the period. Where the deposits of dicotyledonous leaves extend through a considerable vertical mass, it would suggest the possibility of a lignitic deposit near. But this is not verified by observation. The famous deposits of leaves are not in the neighborhood of the lignite, and the thick, massive sandstones of the Dacotah are all below the horizon of the lignitic coal. That the sand deposits were not favorable to the fossilizing of organic forms is well known, and hence there are comparatively few occurrences of fossil wood in the Dacotah. In the lower beds of the Benton there is abundance of it. The specimens are calcareous petrifactions. It is manifest that they represent wood of the Dacotah period, probably of the lignitic horizon, water-logged and imbedded in the calcareous mud of the early Benton seas. There is none in the upper Benton.

There is one other fact that will possibly be of importance in the development of the lignitic horizon in southwest Kansas. In the area in which the Dacotah is known in Kansas there is undoubtedly a change of dip from westerly to easterly in the great body of the formations. We have previously pointed out that this would have a bearing on the water supply of western Kansas, and recent artesian borings at Coolidge and Fowler confirm our judgment. In the Arkansas valley and further south it will have a bearing on the probable supply of lignite for fuel or use in sugar manufacture, for which Prof. Swenson has pointed out its value. The easterly dip of the strata in the valley of the great river is not much different from the slope of the stream. The effect of this is to keep the lignitic horizon not far from the surface over an immense area. In a part of the southwest the cretaceous formations are hidden by the two tertiary deposits, and it may be that they have, by preventing percolation and by added pressure, preserved areas of lignite of better quality than any yet found. Of course the drill only can settle this, but the areas in which it is probable or possible can be approximately determined.

NOTE.—The published record of a drill-hole at Cawker City suggests some exception to be made to some of the conclusions of this paper; but there are some grounds to suspect the accuracy of that record, and in the absence of confirmatory evidence we leave the present discussion of its bearings. Recent discovery by Prof. Hill of another cretaceous horizon in Texas, and the Texan character of the shell bed in Barber county, suggest a possible change in the horizon of the southern lignite which must be determined by further investigation; but it is certain that the horizon exists in the Dacotah as black shale in the more western counties south of the Arkansas river, as Morton and Stanton.

ON THE NEWLY-DISCOVERED SALT BEDS IN ELLSWORTH COUNTY, KANSAS.

BY E. H. S. BAILEY, PH.D.

That there are salt beds underlying many portions of this State, seems to have been recognized for many years. Where deep wells have been sunk the flow of salt water is often abundant, and as we go farther west, the salt waters are nearer the sur-

*The Russell boring does not give more than 375 feet for the thickness of the Dacotah.

face. At Geuda Springs, in Cowley county, and in several other places farther west, brine springs often occur.

A company was formed at Ellsworth the past summer for the purpose of boring a well. The drilling was begun on August 30. The following is a record of the strata, as reported by Col. H. G. Johnston, the contractor:

SURFACE.

	Feet.		Feet.
Yellow clay	40	Light-gray slate	5
Sand and gravel	12	Dark shale	5
Red clay	35	Medium-dark shale	20
Gray soapstone	53	Light and dark slate	30
Gray sand-rock	25	Gypsum	30
Blue clay (impregnated with iron pyrites)	10	Gray slate	45
Gray soapstone	25	Light-gray slate	15
White sand-rock (artesian water)	50	Dark shale	40
Gray sand-rock	15	Light shale	5
Light-red shale	40	Dark slate	15
Dark-red shale	165	Light slate	15
Gray shale	60	Dark slate	10
Red shale	20	Light sand	5
Gray shale	10	Light-red shale	65
Rock salt (salt)	50	Dark-gray sand (gas)	20
Gray slate	5	Gray sandy shale	100
Rock salt (salt)	90	Light sand-rock (salt water)	20

It will be seen by reference to this record that at a depth of 730 feet rock salt was struck in two layers, one fifty and the other ninety feet in thickness, with five feet of gray slate intervening. The salt bed is therefore 140 feet thick. The salt is hard, dry and crystalline, and has the following composition:

	Per cent.		Per cent.
Sodium chloride	95.76	Magnesium sulphate	.09
Water	.19	Potassium chloride	.67
Calcium sulphate	1.21	Insoluble matter	.27
Calcium chloride	.99	Calcium carbonate	a trace.

The sample examined was taken up with the drillings, and was of course somewhat contaminated with scrapings from the slate and shale above. If we consider the potassium chloride as salt, for in most analyses it is so reckoned, it will be seen that the total impurities amount to about three and one half per cent. This be it remembered, is not a manufactured article, nor is it quite as pure as the original salt beds from which it comes. A little of the salt was dissolved in water, filtered, and evaporated to dryness. No attempt was made to separate any of the insoluble material from this. This process gave the pure white sample in the bottle marked No. 2. This contains about 97½ per cent. of salt.

I have compared this analysis with that of some samples of manufactured salt reported by Dr. Motte, Prof. Goesmann and others. These manufactured salts represent much labor and fuel. They are usually made from salt waters, and the more insoluble impurities have been allowed to crystallize out. Sometimes solar heat is used for evaporation, and sometimes the brines are evaporated by steam or over an open fire in kettles. Notwithstanding this process the per cent. of salt is only the following:

	Per cent.		Per cent.
Higgin's	97.8	Deckin's	97.5
Onondaga	97.7	Worthington	97.4
Ashton's	97.6		

So it will be seen that the Ellsworth product compares very favorably with these and it can be obtained with only the labor of mining and hoisting to the surface.

The drilling of the well has been continued. At 1280 feet considerable gas was

struck. It is proposed to continue the boring to a depth of 1600 feet or more. A similar bed of rock salt has been struck at Hutchinson, and from published reports it is about as pure as the Ellsworth sample.

UNIVERSITY OF KANSAS, Oct. 1887.

SOME EXPERIMENTS ON THE RELATION BETWEEN THE TASTE AND THE ACIDITY OF CERTAIN ACIDS.

BY E H. S. BAILEY, PH. D.

Some tests have previously been made on the "Delicacy of the Sense of Taste."*

The following experiments were suggested in continuation of the same general subject. Normal solutions of the following acids were prepared: Sulphuric, Hydrochloric, Nitric, Tartaric, Citric, and Acetic. These solutions were diluted so as to make six series; each solution in a series being of one half the strength of the preceding one. The dilution was continued until it was impossible to taste the acid. The stronger numbers of each series were set aside, and the bottles containing the solutions together with some bottles containing water were placed without regard to order upon the table.

Tests were then made upon these solutions by twenty persons, including some of both sexes. By tasting of these solutions they divided them into two classes, water and acid. The more dilute solutions they usually set aside and tasted a second time, in order to confirm or disfirm or disaffirm the first impression.

There was remarkable uniformity in the results. As the solutions were of the same acidimetric strength, it was possible to compare them exactly. In nearly all cases the solution which was $\frac{1}{128}$ of the normal was the most dilute that could be tasted. This was especially true of the mineral acids. In quite a large number of cases the solution which was $\frac{1}{64}$ of the strength of the normal was the most dilute *organic* acid detected.

There seems to be, therefore, a slightly greater ability to taste the mineral than the organic acids. Whether this is due to some special or characteristic taste of the former, or to its greater persistence, cannot be determined. No attempt was made to name the different acids when thus diluted, and indeed it would require greater delicacy of taste than is usually possessed.

It was noticed that after standing a short time a variety of molds developed in the dilute organic acid solutions. These were kindly examined for me by Mr. V. L. Kellogg. He noticed especially that there seemed to be some special variety of plant which was the *prevalent* form in each acid, although this did not prevent some specimens of other species from being also present. As the molds developed, the acids lost their strength, as measured by the sense of taste, so that after several weeks no acid could be detected in several of the more dilute solutions. There is no doubt but that the vegetable forms grow at the expense of the organic acids, but how the acids are broken up, and what conditions are necessary, we have not yet determined.

These tests seem to show that the method adopted in the taste experiments is in general an accurate one. Also in this particular case the acid taste corresponds with the actual amount of acid present as determined by saturation with an alkali.

*On the Delicacy of the Sense of Taste, by E. H. S. Bailey and E. L. Nichols: *Science*, March, 1888; also, *Nature*, March, 1888.

ICTINIA MISSISSIPPIENSIS AND ÆGIALITIS NIVOSA, NESTING IN SOUTH-CENTRAL KANSAS.

BY N. S. GOSS.

While collecting in the State, I found, May 9th, 1887, quite a number of the Mississippi Kites sailing over and into the timber skirting the Medicine river, near Sun City, Barber county, and from their actions knew that they were mating, and upon their breeding-grounds—a lucky find, one worth following up. On the 11th I noticed several of the birds with sticks in their bills, (green twigs in leaf,) flying aimlessly about, as if undecided where to place them, keeping hidden within the trees as much as possible, dropping the sticks when from fright or other cause they rose much above the tree-tops. I however succeeded in tracing one of the birds to an old nest in the forks of a cottonwood. Having thus located the birds, and knowing it must be some time before they would begin to lay, I left for the salt plains on the Cimmarron river in southwestern Comanche county, and in the Indian Territory, where I found the Snowy Plover quite abundant. (See *The Auk*, vol. 3, No. 3, p. 409, in regard to finding the birds nesting in the same vicinity, last season.) I returned to the Kites on the 16th, and remained watching the birds until the morning of the 22d, at which time the nests found, seven in number, appeared to be completed, and I saw a pair of the birds in the act of copulation. A business matter called me home, and I hired the man with whom I stopped to climb the trees on the 28th for the eggs, but a hail-storm on the 25th injured the nests badly, and in one case beat the nest out of the tree. On the 31st he collected four sets of two eggs each, and one with only one egg. It being a hard tree to climb, he decided to take the egg rather than to wait to see if the bird would lay more. Not hearing from him, I returned to the grounds June 10th, and put in the day examining the nests, etc., collecting two more sets of two eggs each, one of the sets nearly ready to hatch, but with care was able to save it. The eggs are all white, or rather, bluish white, without markings, or shell stains. It having rained nearly every day since the commencement of the month, the last two sets collected are somewhat soiled and stained by the wet leaves in the nests. The eggs measured by sets as follows, viz.: First, 1.55x1.33, 1.52x1.36; second, 1.76x1.48, 1.65x1.35; third, 1.70x1.39, 1.56x1.35; fourth, 1.70 x1.37, 1.68x1.30; fifth, 1.75x1.30; sixth, 1.54x1.31, 1.45x1.24; seventh, 1.70x1.38, 1.68x 1.43.

The old nests had a few leaves for lining in addition to the leaves attached to the twigs used in repairing the same, but the new ones appeared to be without additional leaves. They were all built either in the forks from the main body, or in the forks of the larger limbs of the cottonwood and elm trees, and were at least from ten to a hundred rods apart, were not bulky, and when old would be taken for the nests of the common crow. They ranged in height from twenty-five to fifty feet from the ground.

FEEDING HABITS OF PELECANUS ERYTHRORHYNCHOS.

BY N. S. GOSS.

Naturalists who have not seen the White Pelicans upon their feeding-grounds have without doubt read Audubon's interesting description of the manner in which the birds unite and drive the fishes into shallow water where they can catch them, which they cannot well do in in deep water, as the flesh side of their skins is honey-

combed with air cells that buoy them up like a cork, and prevent their diving,* neither do they plunge for their food when upon the wing, like their cousins the Brown Pelicans, and therefore have to adopt fishing habits suited to shallow waters. I have often noticed the birds in flocks, pairs, and alone, swimming on the water, with partially-opened wings and head drawn down and back, the bill just clearing the water, ready to strike and gobble up the prey within their reach; if, when so fishing, they ran into a shoal of minnows, would stretch out their necks, drop their heads upon the water, and with open mouths and extended pouches scoop up the tiny fry. Their favorite time for fishing on the sea-shore isduring the incoming tide, as with it come the small fishes to feed upon the insects caught in the rise, and upon the low forms of life in the drift as it washes shoreward, the larger fishes following in their wake, each from the smallest to the largest eagerly engaged in taking life in order to sustain life. All sea birds know this, and the time of its coming, well; and the White Pelicans that have been patiently waiting in line along the beach quietly move into the water and glide smoothly out, so as not to frighten the life beneath, and when at a suitable distance from the shore form into line in accordance with the sinuosities of the beach, each facing shoreward and awaiting the signal from their leader to start, upon which all is commotion, the birds rapidly striking the water with their wings, throwing it high above them, and plunging their heads in and out, fairly making the water foam, as they move in an almost unbroken line, filling their pouches as they go; and, when satisfied with their catch, they wade and waddle into line again upon the beach, where they remain to rest, standing or sitting as suits them best, until they have leisurely swallowed the fishes in their nets; and then, if undisturbed, generally rise in a flock and circle for a long time high in air. Off the south coast of Florida (a coral formation) the shoal water often extends out for miles, and the tide is scarcely perceptible. There the birds have no occasion to dive, but gather their food by coursing, and in such places the Brown Pelicans, so expert, and in dropping upon their prey in deep water are forced, in order to save their necks unbroken, to feed in like manner; this is especially noticeable in the shallow ponds within the Everglades. Several years ago, in the month of September, I had the pleasure of observing a small flock of the birds fishing in the Neosho river, Kansas, when late at eve in their southward flight they were forced by tired wings to stop. The place selected was in still, deep water, at the head of a fall or rapids in the stream, where the water for some fifteen rods, and at a depth of about six inches, was rippling and dashing over the rocks—a natural feeding-ground for the fishes. The birds, after first bathing and dressing up their feathers, giving particular attention to their primaries, would, without any unity of action, as hunger moved them, float down over the rapids, picking up and at the fishes here and there, until the still water below was reached, when they would rise and fly back, to float down again, leisurely repeating this mode of fishing until it was quite dark.

NOTES ON THE YELLOW-TAILED CASSIQUE.

(*Gymnostinops montezumæ.*)

BY N. S. GOSS.

The birds are known by the natives as the "Oropendula," also as the "Inca bird," but are generally called "Yellow-Tailed Cassiques," or rather, "Yellow-Tails." They are quite common in the low forest lands of Central America, on the Atlantic side, but

*The statement in "North American Birds—Water Birds," vol. 2, page 137, that this species "dive with great celerity," is in error.

I did not find them upon the Pacific slope, nor upon the high mountain lands. They are social in habits, going in couples, and generally in flocks of from ten to fifty or more. They are noisy, their voice harsh, coarse and discordant; an indescribable jargon — even their whistling notes are not musical. In their food habits they are omnivorous, but seem to prefer fruits and berries, often doing great damage on the plantations when the bananas, plantains and mangoes are ripening. For breeding purposes they select large thorny trees, in an open space where the limbs of other trees do not touch, so as to be beyond the reach of reptiles, monkeys, raccoons, and other climbing nest-robbers.

Their pendulous, gourd-shaped nests are strongly and ingeniously woven and suspended to the ends of the boughs of the tallest branches, and are made of fibrous strippings from plants and from frond-like leaves, with here and there a rootlet. The bottoms are lined with leaves. Some writers state that the birds build their nests of grasses, but I have been unable to find any in those that I have examined, and I am inclined to think this large species rarely, if ever, use it, and if they do the blades, so brittle when dry, must be of a very strong, hemp-like nature, to long sustain the weight of the nest and its occupants against the wear and tear of the storms and winds.

The entrance is a purse-like slit at the top; the average length of the nest, about three feet; in diameter, at the rounded base, nine to ten inches. I have never found less than five nor more than twenty-one nests in a tree; they are said, however, to build as many as fifty, and even more, but the late growing demand in the States for bananas causes the producers, heretofore so indifferent and indolent, to be more watchful, and the large colonies of the birds are fast thinning out. The only eggs that have come under my observation I collected March 13th, 1887, at Cayo, a small village on the Balize river, in British Honduras, and near its western boundary-line. There were thirteen nests in the tree (a species of locust); these were all hanging from the boughs of one branch, from two to three feet apart, and at least seventy-five feet from the ground, but the dense undergrowth, a tangled mass of young palms, bushes and vines, buoyed up the tree in its fall like a cushion, so that, to my surprise, I was able to save unbroken three sets of fresh eggs, two in each nest; and as the same number of the broken eggs were found in the other nests, together with the further fact that the nests were not large enough to rear over a pair of the birds, I think it safe to enter two eggs as a full set; and I am also led to believe, from the great difference in the dimensions of the eggs and in the size of the male and female birds (see measurements given below), that they are hatched in pairs, and as they go in couples, remain together during life.

First set: 1.49x1.10, 1.42x.96; ground color bluish white, thinly speckled and spotted with brownish black, and dark purple stains.

Second set: 1.49x1.08, 1.40x1.00; ground color bluish white, clouded and marbled with pale rusty brown, and a few zigzag, hair-like streaks of a darker tint, the clouding thickest upon the largest egg.

Third set: 1.50x1.03, 1.40x.98; the first bluish white, without mark or stain (an abnormal egg); the others peckled and spotted thinly with pale rusty brown, and a few faint purple stains.

The broken eggs examined were all specked and spotted with either brownish black or pale rusty brown in marked contrast, the coloring matter by sets, however, largely alike.

A pair of the birds which I shot and mounted in the winter of 1886, at Santa Tomas, Guatemala, measure as follows:

Sex.	*Length.*	*Stretch of wing.*	*Wing.*	*Tail.*	*Tarsus.*	*Bill.*
Female	16.50	24.00	7.50	5.75	1.70	2.30
Male	22.00	32.00	9.75	8.25	2.00	3.60

THE BLACK ROT OF THE GRAPE.

BY CHAS. R. CARPENTER, M. D.

Of the diseases of the grape, probably none is more destructive than that which is known as the Black Rot, where it occurs in a pronounced form. And in this State, where it occurs in its most destructive form, it is important to viticulturists that they understand the causes of the disease, the conditions under which those causes become operative, and the intelligent method of treatment.

After the investigations of Scribner, Trelease, Ellis, and others in this country, and Viala and Ravaz in France, it would seem almost superfluous to discuss the question whether the rot is a parasitic or a trophic disease. Nevertheless it is being discussed, and good arguments being adduced on both sides; both good, for the reason that both are correct.

No profound result is accomplished in nature by the action of a single isolated cause; and it is no more to be expected here than elsewhere. To argue that the *phoma uvicola*, or as its mature form is now called, the *physalospora Bidwellii*, does not operate as a cause in this disease, is to invite the suspicion of a limited knowledge of the character and natural history of this fungus. To argue that the trophic condition of the vine does not operate also as a cause, is to argue that a man who is starved, whose blood is vitiated from the absence of proper food, whose tissues are imperfectly sustained, and whose entire functional organism is impaired, is not more susceptible to the advent of disease than a man who is strong, well-nourished and healthy at the time of exposure. The hard and fast rules of common sense are to be applied to the physiology and pathology of vegetable organisms in the same manner as they are applied to the physiology and pathology of animal organisms.

To one accustomed to study the causes of things it seems almost inevitable that an imperfect nutrition of the individual, whether animal or vegetable, and a correspondingly low condition of vitality, should invite disease. Disease may be defined in general terms as any interference with the natural process of waste and repair in an organized body, and the mechanical results of that interference. If nutrition is withheld entirely, dissolution is the result. If it is withheld partially, dissolution is favored, because the conditions are furnished which are necessary for the operation of those causes which produce an entire interruption of the process of waste and repair.

We may have an interference with the process of waste and repair which does not affect the entire organism. It may affect a very small portion of the organism, and hence we have hundreds of trivial diseases which produce no tendency to dissolution whatever in the general organism. The black rot is a grave disease, tending to direct and immediate dissolution in that part of the organism affected, the fruit. And hence any condition which favors dissolution favors the operation of any cause that is capable of producing the disease. Deficient nutrition manifestly favors dissolution; it therefore operates as a predisposing cause of the black rot. But deficient nutrition operates as a cause of disease in general, because it is a general condition. It predisposes to any and all diseases, systemic as well as local.

What then determines the advent in one case of the black rot, in another the grape mildew, in another the powdery mildew, and so on through the whole list of the grape diseases?

Some would argue that a deficiency in the supply of some particular element or elements might give character to the different diseases, and that the three species of fungus that occur so evidently in the three diseases mentioned are simply three accidental growths; that they do not act as a cause, but are simply a result.

If they are a result in any sense, they are a necessary result; because they occur invariably.

Not a single specimen of the black rot in any stage has ever been placed under a microscope without revealing the presence of the characteristic fungus, distinctly correlated to the stage of decay found in the specimen. If the fungus was only a possible result, specimens would inevitably be found among the thousands examined, in which the fungus was absent. If it is not a result, it must be a cause.

It is a cause.

It is the exciting cause, and no matter how much the vine may be predisposed to the disease, without the action of the exciting cause the rot will not take place.

The history of the advent of the disease into France is of itself sufficient to prove that some peculiar and special condition is necessary as an exciting cause to produce the rot.

For hundreds of years France had been one of the greatest vine-growing countries in the world. She had furnished fruit for every market in the world, and her wines were to be found in every city in the world. The vineyards of France were a national pride. The vines were tended, pruned, trellised, and fertilized with the greatest care. Diseases of many kinds showed themselves, but were nearly always controlled by ordinary measures; and never was the black rot known in France until the year 1885, two years previous to the present writing.

The same treatment of the vines has been pursued since; the same method of pruning, trellising and fertilizing has been used, but the spirit of Death stalks on through the luxuriant vineyards, touching with his deadly finger berry after berry, cluster after cluster, and they die.

The fruit forms and grows beautifully up to a certain size, giving promise of a magnificent yield. No prospect could be finer. Suddenly a minute spot appears here and there upon the surface of a berry; a whitish or yellowish spot which may be elevated like a blister on the human skin. Rapidly a dark areola forms around it; then a system of concentric dark rings with lighter spaces between which gradually give way to the uniform dark-brown color of the disease. Other spots appear and pursue a like course; then others, and still others; all enlarging rapidly until, in an amazingly short space of time, the entire vineyard is studded with rapidly darkening berries. Whole bunches are blighted; but each individual berry is made the object of a separate attack. Not a leaf, not a stem, not a petiole is affected primarily; only the beautifully clustering fruit which looked so fair, and promised so fairly.

It is a striking phenomenon, and one which almost unconsciously prompts the question: "What can be the cause of all this untimely death and decay?"

Not until the searching eye of the microscope was turned upon the object of our study were we able to answer satisfactorily this question. It would seem that the seeds of death had been sown broadcast by an invisible hand; and, indeed, this is about what occurs, as we shall see.

As early as 1861 the *phoma uvicola* was observed and described by Dr. Englemann, but its natural history is so complex that all the years intervening between that time and the present have contributed very little to our knowledge of it, until the last few years, when Viala and Ravaz, Scribner, Trelease and others have again taken up the subject.

At any time after the whitish spot has declared the presence of the disease in the berry, a cross-section through the affected portion will show the threadlike hyphæ of a mycelium burrowing between and through the cells of the grape tissue. In the early stage of the disease the growth of the mycelium is confined to the tissue underlying the epidermis, but as the disease progresses it encroaches more and more

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urface which characterizes the disease in its active stage; but we have not observed he affected portion of the berry to become black or shriveled until the vegetative areer of the mycelium is apparently checked. Then the spermagonia make their appearance on the surface, always at or near the point where the disease began, and hen the part immediately around and under them begins to grow black and shriveled.

These two forms of fructification, in all probability, serve for the immediate listribution of the fungus during the summer season. And from the fact that the onidial, or third form, is only observed late in the season upon old diseased berries, and the fourth form in the spring, it is probable that they are the means by which the species is preserved from one season to another; in other words, that they furnish the winter or resting spores.

The *conidia* are little hair-like projections, which under favorable conditions grow up from the surface of pycnidia, from which the contents are being extruded. They are erect, and bear upon their distal end a few scattering spores.

The fourth or supposed mature form is produced in the spring — about the month of May, it is said — by the action of warmth and moisture upon old diseased berries. A fruiting body is formed similar in every way to the first two, except that it contains little elipsoid bodies called asci, which are fastened by one end to the bottom of the capsule. These in turn contain a certain number of spores or germinating bodies. This form is called the *sporidium*.

The conditions necessary, then, for the advent of the black rot, are a lowered vitality from imperfect nutrition, whether caused by exhaustion of the soil, by overbearing, or both; and the presence of the germinating bodies in some form of the *physalosporo Bidwellii*.

These conditions being present, how are they to be dealt with by the viticulturist?

Build up the strength of your vines with plant foods; fertilize, in other words, and replenish the elements that have been exhausted from the soil by the constant growth and bearing of the vines.

Husband the strength of the vines also by cutting back; by trimming off the old wood; and by preventing heavy crops.

Destroy every vestige of the diseased fruit which may have remained over from the previous season; destroy it by fire. And as a therapeutic measure, when the grapes have attained a size at which they are from the surrounding conditions liable to an attack, or when the attack has been precipitated, use sulphurous acid gas as a germicide.

Use it in the following manner: Take a stick of roll sulphur and place it end to end with a wooden stick of convenient length. Roll them both in a piece of thick coarse cloth, such as a gunny sack, and light the sulphur. The cloth will cause it to burn slowly like a torch.

Take the torch in one hand and a watering-pot in the other. Sprinkle the fruit slightly, and then fumigate. The water absorbs more or less of the gas, and holds it *in situ* for a greater length of time than it would otherwise remain.

Sulphurous acid gas is one of the most powerful germicides known; sulphur is cheap, and the method effective. The operator can walk along his trellises and in a very short time fumigate to a sufficient extent a large vineyard.

So far as is known, Dr. Langworthy, of Leavenworth, is the originator of this method, and to him is due the credit of an important advance in the treatment of this disease, as well as the thanks of viticulturists.

upon the body of the tissues, decomposing and sucking up the cell contents for its own nourishment, and hence breaking down those tissues by destroying the trophic functions.

The progress and extent of the rot, then, in each berry, is in direct correlation with the growth and vigor of the mycelium; and when the growth of the mycelium for any reason becomes checked, the progress of the rot is checked at the same time. In passing through a vineyard one may find berries in which the rot has been checked in all stages, from a minute speck to a spot equal to one eighth or a quarter of the berry. In such cases the berry goes on to maturity as though nothing had happened, except that it carries this dark scar upon its cheek. Even when one-half or more of the berry has rotted, the remaining portion may go on to maturity, but the nutrition is so impaired that it frequently shrivels up, though the decay proceed no farther.

Now a proposition which we wish to submit is, that fructification of the fungus checks the growth of the mycelium; hence checks the progress of the rot in that particular berry. Conversely, that checking the growth of the mycelium hastens fructification; from the fact that it draws the attention of nature to the necessity of accomplishing this crowning act before it is too late.

Observation bears out this proposition.

All observers agree that fructification of this fungus takes place in four forms; but no single observer has ever been able to identify all four of the forms. Scribner found two of them only in his own researches. Mr. Erwin Smith is his authority for the third; and the fourth was observed by him in a specimen furnished him by Mr. Ellis.

In examining a large number of specimens, the writer was able to observe only two of the forms — the same described by Mr. Scribner.

When the mycelium is checked in its vegetative career by the stimulus of nature to prepare for the crowning act of its life, it bends its energies to the production and growth of little perithecia or capsules for the protection of the spores which are destined to occupy them.

Two forms of perithecia are now produced directly from the mycelium, immediately beneath the epidermis, bulging it up in minute elevations which give to the surface a pimpled appearance. Of the two forms, the *pycnidia* are the larger, more scattering, and earlier in appearance; the *spermagonia* the smaller, more closely aggregated, and by far the more numerous. The spores contained in the pycnidia are called stylospores; because they are borne upon little styles seated upon the base of the capsule. They are extruded through the raised epidermis by the flow of the viscid contents of the capsule through any rupture in its surface. The spermagonia contain minute spores called *spermatia*, because there is at least a probability that they are the male element of reproduction. If this be the case, analogy and the existing conditions suggest that the stylospore of the pycnidia are the female element.

Scribner says: "Not infrequently the first evidence of the disease is the sudden appearance of one or more circular, slightly-depressed spots of a bluish-black color, in the center of which there soon appear a few of the little pimples or pustules referred to. These spots increase in size, the pimples in number, and ere long the berry exhibits the usual black and shriveled appearance."

The observations of the writer do not corroborate this statement. Wherever these blue spots were found, and they were not infrequent, they were never observed to grow larger, although the number of pimples might increase. The appearance of the spermagonia upon the surface in the shape of pimples seemed to be a signal for the advance of the rot to cease, and the portion which had already rotted to become bluish black and shriveled. The pycnidia may occur earlier on the smooth brown

surface which characterizes the disease in its active stage; but we have not observed the affected portion of the berry to become black or shriveled until the vegetative career of the mycelium is apparently checked. Then the spermagonia make their appearance on the surface, always at or near the point where the disease began, and then the part immediately around and under them begins to grow black and shriveled.

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NOTES ON CIRCULATION OF SAP.

BY W. R. LIGHTON.

I wish to call your attention briefly to some of the results obtained in the performance of several experiments upon the sunflower, bearing upon a question of considerable interest — the circulation of sap.

First, in the early spring, when the stalks of my more vigorous plants had attained a diameter of about three-quarters of an inch, I had recourse to a venerable experiment — the simple binding of a string tightly about the stem.

In several of the plants selected the growth was so vigorous and the bark so tender that as the stem increased in size the string cut through and was imbedded in the tissue beneath; but in several other cases the experiment was a success.

After the operation of tying, the stalk continued to develop normally above the ligature, except for à space of about two inches immediately above it, where there was an abnormal increase in the size, while careful measurements showed that further growth below the string was almost entirely checked.

This partial stoppage of the circulation apparently did not interfere in the least with the process of maturing of the plants, as they went on uninterruptedly to the completion of their mission, and reached the periods of flowering and seeding at the same time as did their brothers with which I had not interfered, and there was no noticeable decline in the vigor of the leaves and branches above the stricture — in fact there were many of the plants which were growing within a few feet and not subjected to the tying process which were much less healthy in appearance.

When further growth of the stalks had stopped I made careful measurements, which showed that the average height of the tied plants was equal to that of the plants not tied, some of them reaching a height of fifteen feet.

As before stated, the growth of the stalk below the ligature was almost, or quite stopped, the circumference at this place in the larger stalks being but 2¼ to 3 inches, while the circumference about a foot above the place of binding was from six to eight inches in the same plants, and the circumference at the point of abnormal development above mentioned was from eight to eleven inches.

A number of dissections and microscopical examniations made after six weeks of growth under these conditions showed that the stalk below the place of binding had an extremely small quantity of cellular tissue in its composition, but was composed almost altogether of the vascular or woody tissue, while the stalk above showed, as compared with other stalks in normal condition, the usual development of cellular tissue, while the enlargement just above the ligature showed an excessive development of the cellular tissue.

Other stalks were tied later in the season, before the time of flowering, but when the stalks had attained to almost their full size, but these effects were not observed, with the exception of one case where there was a slight enlargement.

As you know, in the performance of a surgical operation it frequently becomes necessary to tie an artery or large vein to prevent loss of blood, and in such case the flow of blood thus stopped is diverted into other channels, and the smaller veins or arteries having their duties thus increased, are increasd in size and strength in proportion.

Early in the season while the flow of sap was strong in the young plants, several experiments were tried which gave results that would seem to approximate those obtained in surgery under the conditions named above, although it is generally acknowledged that there is no exact parallelism between the flow of sap in plants and the arterial and venous circulation in animals.

Rectangular incisions were made averaging one-third of an inch in width and extending two inches lengthwise of the stem and of varying depth, some simply extending through the outer bark, others slightly into the woody fiber, and others to the heart of the stem.

The cut surfaces were speedily healed in the ordinary way, leaving the rectangular opening, and the sap which formerly flowed through the severed tissues was forced to find other channels.

When the incision extended only through the outer walls of tissue, an enlargement occurred at the upper end of the wound, being immediately at the sides of the cut, rather than above it, as would be the case if it were simply an enlargement resultant upon the severing of tissues, while when the incision extended deeper into the woody tissue this enlargement occurred at both the upper and the lower ends of the incision. Dissection and examination showed a slight increase in the amount of cellular tissue just surrounding the wound, as would be expected from the healing. Perhaps twenty plants were thus treated at the same time, always with the same result.

In other cases small splinters of wood, bits of wire and other foreign substances were forced into the stalk, and in such cases these substances were enfolded by the aggregation of a considerable amount of cellular tissue, or, in a manner, they would be encysted.

These few experiments, rude and incomplete from a strict scientific point of view, and undertaken when I had not time to follow them up as carefully as I could have wished, have yet yielded some curious results, and have suggested other experiments which shall be made during the coming year.

PERSONAL OBSERVATIONS UPON THE FLORA OF KANSAS.

BY MRS. A. L. SLOSSON, LEAVENWORTH.

The flora of Kansas has received considerable attention for some years, and many lists more or less comprehensive have been published. None of these even in the judgment of the compilers have been at all complete, and from the very necessities of the case, being more or less local, were limited in their range, and untrue in some of the general conclusions.

The location of Kansas being central, its vegetation partakes of the North and the South, of the fertile prairies of the East and the barren plains of the West; and though it may lack the plants that require the mountains for their home, yet our variety of soil gives us also a great variety of plants, and our long seasons and genial climate promote their growth. Our flora, moreover, is rapidly changing from various causes, among which are cultivation and the introduction of new plants, climatic changes, freedom from prairie fires, and the increase of timber and hedges.

It is a well-known fact that where the prairie sod is once destroyed it never reappears, but an entirely new and different vegetation comes, which is nearly the same in any given locality. An illustration of this that I never heard explained occurred after the last grasshopper raid in northern Kansas. The grasshoppers ate the grass to the roots in the fall, and in the spring kept it down until mid-summer, so that where it was trodden at all, as in yards, by the roadsides, and such places, it was entirely killed; even where it was blue-grass, that too shared the same fate; but late the next season the soil was covered thickly with a soft, low, pale grass unlike any that had ever been seen there before. The farmers called it "grasshopper grass,"

but when it seeded it was found to be identical with the buffalo grass, which at that time was abundant 150 miles west of there.

It is said the reason why the weeds thrive where our flowers die is "that the ground is mother to the weeds, and only stepmother to the flowers." If so, then Kansas is a very generous stepmother, for the readiness with which she adopts new plants is marvelous.

We all have seen the little circle of blue-grass spring up on the prairie where the prairie schooner dropped anchor for the night; and only give blue-grass or white clover plenty of rain and half a chance and either will utterly exterminate the native grasses.

Acres of cornfields have been rendered almost worthless by the well-known morning glory; let it once escape from cultivation and its persistence is worthy of imitation. The same may be said of the Melilotus alba, or sweet clover, which in the East is a tender plant and requires care, but here preëmpts and occupies fields and roadsides for miles and miles, making a perfect paradise for bees, and even takes possession of the railroad in such quantities that its fragrance is very perceptible to the passengers. Experience has taught me not to place implicit faith even upon Wood's Botany as to what plants are introduced, as once in a trip across the State, from the river to the Rocky Mountains, in a wagon, about seventy miles from the river a new flower was found, and upon analysis I named it Cleome speciosissima or spider flower, which is often cultivated for bee food as well as flowers, and as it is said to be a native of Mexico, it had escaped from cultivation; being near a town, it was the more probable; but the ridicule I endured was a thing to be remembered when in a journey of 1,000 miles we saw it at intervals, and in southern Colorado so abundant that a valley was so purple with it as to be called "Red Ravine." The same plant grew last year in Leavenworth, on the south esplanade, between the street and the river; whether native or escaped from cultivation, I do not know.

Another plant we first found upon the Blue river was one which is or was put down by Kansas botanists as introduced, and I had that summer left it growing from sale seeds in my garden — the Argemone Mexicana. Of course that had escaped; but when we found it day by day, until at the foot of the Sangre Cristo range there were whole acres of it, and other varieties and different colors not found in the Botany at all, that plant was added to the list, which daily grew longer, until if a camellia had been found upon the prairie, no one would have dared said "escaped from cultivation," or suggested that it was not a native — only a carpet-bagger.

The Abronia umbeleta, sold by florists, was found in the greatest profusion in our western counties; it is only less beautiful than the trailing arbutus, which it greatly resembles, yet I never saw it in a list of our plants, and it is accredited to the Pacific coast. The same is true of the hardy verbena, sold by florists under the name of Verbena Montana, yet it grew in the greatest beauty and fragrance only three counties west of us. I think it is identical with Wood's Verbena aubletia. Our State line is not so definitely marked upon our western frontier as at the eastern State line, yet I am very sure a very remarkable plant was native in our State at that time. The bush looks some like a willow clump, but it is not woody, and it bears in June and July immense flowers not unlike pumpkin blossoms in size and shape, but the color is reddish purple.

I first saw the plant in the Platte, beyond Kearney, but being on the cars could not obtain any. Its appearance was so peculiar I remembered it, and some time after Orange Judd gave a description and cut of it in the *Agriculturist*. He said the roots grew as large as a flour-barrel. Several years later, in 1878, I found it again near our western border, and identified it in Porter & Coulter's survey of Colorado, as Ipomeal leptophylla; but that says nothing of the root, and calls it an annual (with

a question-mark,) which it would not be likely to be with such a root. To make sure, I repeatedly spent my camping-time digging with such tools as I had, but several inches down failed to show any enlargement of the root, which was about the size of the stalk so far as I could go. At last some fellow-pilgrim left a spade in our way, and my brother attacked a very small plant and dug down perhaps six inches, and then it spread out like a jug with a long neck, and the whole root of that small plant was longer than a pail and nearly as large around in the center, of an irregular shape some like an immense yam. So my big-root theory was proved and the secret of its vigor revealed. That plant is ornamental, and will stand drouth, too.

For a long time I believed the common yarrow to be introduced, as the country had been settled at least ten years before I saw it, but my belief in that is shaken, as I never sent for flowers by friends, when they went to an unknown region, but they inevitably brought yarrow. I have had it sent from Texas, Utah, Pike's Peak and Long's Peak, Colorado, and at last from the Alps and Germany; so its nativity is very uncertain.

It is certain that vegetation near the Nebraska line was different when it was first settled from the central or southern part of the State, from what it is now, as many plants were very common that in some of the published lists were marked rare. It was my privilege to explore in the northern tier of counties before the Indians had left, and not long after the white men began to settle in Coronado's "land of crooked-backed oxen, mighty plains, and sandy heaths, smooth and wearisome, and where, too, the earth is strong and black, where were found prunes like those of Spain, excellent grapes, mulberries, and delightful flowers;" but no Botany was there except Mrs. Phelps's, based on the old system, and my knowledge of botany was very limited, and for ten years no other person was there at all interested in the study. However, it did not require technical knowledge to remember what flowers came first, what soil they grew on, or to mourn over the disappearance of some of the most rare, or to exult over the abundance and beauty everywhere displayed.

What landscape gardener, even in these days of massing color, dares dream of miles of phlox (Carolina), so nearly solid as to seem a mass of rose-pink? Yet the wide bottoms of the Nemaha presented just that view. With all the rage for yellow, has anyone imagined acres of rocky bluffs covered with the stately pentsteman (*Digitalis*), that one hour before sunset gave no hint of the coming glory, then almost at once burst out a solid mass of the gorgeous enothera (*Missouriensis*), every tint from the most delicate buff to an orange red, each bloom several inches across, and silky as a begonia? Go a little farther up to the prairie and you find different varieties of enothera — a long list, some white, some pink, some prostrate, and some four feet high.

Who can tell of the beauty in the fringe of timber when the wild crab, with its blush of pink, the plum with its mass of fragrant white, the grape with its tinted tassels of mignonette perfume, the weird red-bud (*Cercis Canadensis*), with its naked boughs hung with drops of bright crimson, when these displayed their banners over a carpet of violets, blue, white and yellow, growing beside the delicate corydalis (*Aurea*) and dicentra (*Cucullaria*), with here and there a stalk of early larkspur, or (*Del. Azuratum*) a mat of strangely mottled leaves bearing the lily-like erythronium, or the purple phlox (*Pilosa*)? No crazy-quilt or ribbon-bed in Shaw's garden was ever more brilliant than our autumn display of composite, asters, etc., daisies of all sizes and colors mingled with the stately liatris or royal purple of the iron-weed (*Vernonia fasciculata*), with the electric blue of the salvia (*Agurea*), and the sunshine of the ever-present golden rod (*Solidago*).

As for sunflowers, our State was rightly named, for wherever the sod was broken by the wheel of the heavy freight wagons on the old California trail, there grew the

sunflower; wherever the track is laid for a railroad, there it grows. No wonder strangers passing through see nothing else. Call it gaudy, coarse and self-asserting if you will — it is persistent, hardy, bright, ever reaching upward and turning its face toward the light, and so is an emblem of a true Kansan. Long may it wave.

I have spoken thus of some of our flowers, as a mistaken idea is held by newcomers and dwellers in our towns. Not long ago a gentleman at the head of one of the finest schools in the State said our wild flowers would not compare with those of other States — New York for instance. Astonishment gave way to amusement when on inquiry it was found his research was confined to a portion of the country settled for thirty years and seeded with tame grasses. As well assert that there never were Indians in the State because there are very few now. I sincerely hope the time is not far distant when a systematic effort to preserve and cultivate our most valuable flowers will be made. It is worth it on the score of beauty, and desirable because they are adapted to our soil and climate. The florists of the Eastern cities do sell the seeds of perhaps a dozen sorts, but so change the name that only by personal observation can we identify the little waif whose name and pedigree were so laboriously ascertained when we met the nameless one at home on the prairie.

A lady once bought of Vick a dozen seeds of a beautiful foliage plant called "Snow on the Mountains," and succeeded in getting half a dozen, perhaps, to bloom just before frost, only to find that the bluffs back of her house for miles were just covered with the same flowers, and had been for three months. Yet it is well worthy of cultivation, and is very showy; grows on the banks of rivers all the way to the Smoky river, where it is very luxuriant and seems to enjoy the lack of rain. Its name is *Euphorbia marginata*, and it is own sister to the brilliant poinsetta, whose scarlet-velvet sprays are worth a dollar each at holidays. The *Ascelepias tuberosa*, also known as pleurisy root and butterfly weed, is also sold, and is a brilliant, hardy perennial that stubbornly refuses to yield to the usurper, but sends its finely-folded, orange-red clusters defiantly up among the clover, under the apple trees, and even in the garden. Its root runs underground a long distance, and probably is not removed by the careless plow.

It is high time that as patriots who have the good name of our State at heart, that as scientists who deserve the credit of their research and desire others to share its benefits, this Society proceed to have issued in a cheap, available form a complete and descriptive list of our native and acquired flowers, so that our students who do not have access to large libraries can know where to place their specimens.

It is time some one began to cultivate our wild flowers, as soon some of them, like the Indian and buffalo, will be forever gone. Once the school children brought armfuls of the curious elkhorns, as they called them, or orchids (*Leucophea*) — now they are seldom seen; once the gentian, like a blue tulip, defied the late frosts, and bravely held up its cluster in the brown grass — now one may not see them in years. And so with others.

Thus grown together in some park, with a convenient list at hand, botany would possess new charms for our students, and teach them "to look up through nature to nature's God." It is said the undevout astronomer is mad; and it is equally true of the botanist, for the more we know of the wonderful structure of plants the more we are led to say; "Wonderful are thy works, O Lord God; in wisdom hast thou made them all," and to believe it is the part of true wisdom to "consider the lilies how they grow."

THE SOLUBILITY OF CHROME YELLOW IN THE GASTRIC JUICE.

BY PROF. L. E. SAYRE.

It has hitherto been advanced as an opinion among physiologists, that the chromate of lead is non-toxic in property. This belief has been based almost wholly upon the supposed insolubility of the salt in the gastric fluid and other fluids of the intestinal tract.

This subject has been recently revived, and much prominence given to it by several cases of alleged lead-poisoning, from the use of chromate of lead, in Philadelphia. It appears that the bakers in that city have been using this salt quite freely as a pigment. To give certain cakes a peculiar yellow color, they have used chromate of lead instead of the yolk of eggs. Children, and others, who have indulged in the use of these products of the bakery, have become victims of lead poisoning, and in some cases death has been the final result of long-continued use of such adulterated food.

I need not speak of these cases in detail, but will briefly refer to a verdict of the coroner's jury in the cases of four persons who died from supposed lead poison, on various dates.

This jury stated that the deaths, in their opinion, were due to chromate-of-lead poisoning, and that this poisoning resulted from the use of chromate of lead "as a coloring matter in buns and other breadstuffs."

Investigators have again taken up the subject, and have arrived at somewhat conflicting conclusions. One states that these cases were those of chronic lead-poisoning, and not due to the presence of chromic radical in the least. It is stated further that chrome dyes have been in general use since 1828 at least, thousands of tons being consumed annually in America alone, and that it is important to note that there is not known to exist among the workers in any of the forms of chrome colors any chrome disease or chrome poisoning from contact, from inhalation, or otherwise. Another, a physician, states that any of the modifications of chromium may be poisonous, and cites four cases where poisoning occurred from the use of insoluble salts of chromic acid.

It is well known that the gastric fluid is an acidulated solution, and as a solvent it has a comparatively wide range of action. It contains about two-tenths per cent. of acid. The digestive principle contained in the gastric fluid is recognized as *pepsin*. It is possible to make an artificial gastric juice by separating the digestive principle from the inner lining of the stomach and making an acidulated solution of it.

My experiments with lead chromate consisted of making an *artificial* gastric fluid, and macerating in this fluid at the temperature of 100° F. a certain quantity of commercial chromate of lead and noting the effect.

It is known that any metallic substance, if it enters into solution, will very markedly impair the digestive action of artificial gastric fluid. Lead salts will absolutely destroy digestive action. If, therefore, after digesting chromate of lead in the gastric fluid the action of the fluid is at all impaired, it is a positive evidence that the salt has gone, to some extent at least, into solution.

Thirty grains of chromate of lead were mixed with one fluid ounce of artificial gastric fluid, the digestive strength of which had been carefully noted. It was found that the digestive action had been slightly impaired, but not enough to account for lead chromate entering into solution, for the slightest quantity of a lead salt will produce a marked impairment.

Subsequently I prepared a chemically pure chromate of lead, and experimented

with it in the same way. I found that the pure salt did not interfere in any way with the digestive action of the fluid, and therefore the inference is that the pure salt is insoluble in the gastric fluid. An analysis was made of the fluid after it had been standing at 100° F. in contact with the pure chromate; no reaction indicating the presence of the salt could be obtained.

Prof. E. H. S. Bailey has since examined the commercial chrome yellow, and finds it to contain variable quantities of barium and calcium sulphate. The latter salt is sufficiently soluble to account for the above modified action of the digestive fluid.

Dr. Marshall, of Philadelphia, has made some physiological experiments upon dogs which lead him to believe that chrome yellow is decomposed by the muriatic acid of the stomach. The so-called poisonous property cannot be due to the solubility of the salt, but it might be accounted for by the gradual decomposition of the salt in the tissues, which retain considerable portions of the insoluble powder.

ON THE OCCURRENCE OF NITRITES IN RAIN-WATER.

BY PROF. G. H. FAILYER.

As a part of our work upon the nitrogen compounds occurring in rain-water we have tested qualitatively for nitrites, using the test proposed by Griess and modified by Warrington.* The test is almost too delicate to be used quantitatively, but in all cases we tried to grade the color produced by a purely artificial scale; such as faint, distinct, strong, very strong. In general, as might be expected, the depth of color produced varies inversely with the amount of rain, since the first portion of the fall would serve to wash the air, and any subsequent fall would only dilute the solution. But the amount of this has been quite variable, for extremely heavy rains have sometimes shown good reactions. This may be due to the production of nitrites during the shower, or, in a long-continued rain, the air being renewed at any one place may bring in fresh supplies of the salts.

To illustrate the results obtained, I give a summary for the year justclosed (Oct. 1886 to Sept. 1887, inclusive.)

Month.	*No. of rains....*	*No. giving reaction.....*	*No. giving no reaction..*	*Doubtful.....*
October	2	2	.....	.....
November	2	2	.....	.....
December	3	3	.....	.....
January	3	1	.....	2
February..	6	.....	4	2
March	5	.....	2	3
April	8	8	.....	.....
May	10	7	2	1
June	12	12	.....	.....
July	7	7	.....	.....
August	8	4	2	2
September	3	3	.....	.....
Total	69	49	10	10

It seems remarkable that so many of the rain-waters should show the presence of nitrites. It is equally remarkable that the winter months should be deficient in these compounds. Is it because oxidation is then at a minimum, or is it that reduc-

*See Journal of the London Chem. Soc. for May, 1881.

tion from nitrites is then at a minimum? On the other hand, it may be that this is merely accidental, and another year may show contrary results. When our observations have extended through a greater number of years we will be better prepared to discuss these interesting questions.

ULTRAMARINE BLUE IN SUGARS.

BY H. L. RAYMOND, PH. D.

There seems to be no end to the "fixed" or adulterated goods in the market, and sugar is no exception. It would seem with the late improvements in sugar-refining as if there would be no need of this. It is not sand to which we call the attention of this body of scientists, but bluing.

We find upon examination that the refiners are learning something from the washerwoman — whitening their sugars by means of a color, and that color ultramarine. In this bottle are six grains of the pigment, the amount found in three hundred grains of sugar. For many ordinary purposes this does not seem to have any deleterious effect, but to the pharmacist it causes both trouble and annoyance. Ultramarine is a sulpho-silicate of aluminium and sodium. The quantity used is small, but enough to impregnate fruit syrups and those containing free acid with sulphuretted hydrogen, thus imparting to them a very disagreeable taste and odor. Many a housekeeper can testify to the annoyance caused by this adulteration when she finds, upon opening a jar of fruit, that instead of the delicious fragrance expected, she is greeted by an odor familiar to unpopular orators. The acid of the fruit does the business.

Prussian blue is also used, but that has not shown any unpleasant effects. We suppose ultramarine blue is generally used because it is cheaper.

The presence of the latter is detected in several ways. The easiest test, if there appears to be a large quantity of the adulteration, is to dissolve one part of the suspected sugar in twenty parts of water, and allow the solution to stand. If there be any blue, it is shown by the bluish precipitate on the bottom.

By the use of the microscope, we may detect the presence of the ultramarine when the adulteration is much less, and on account of the peculiar crystals, which are readily distinguished.

Prof. Nichols, late of the State University, with the assistance of Prof. Franklin, has made some very interesting experiments with the spectroscope, which are of value to us on this subject. By this means, we can determine the presence of any coloring matter in sugar. It is shown by comparing a spectrum of a pigment, having a known white surface, with the polarized spectrum of the suspected sugar under precisely the same conditions.

(As a note, here would say that Prof. Nichols states that nearly every white substance in the market is made so by the use of blues: for example, carbonate and sulphate of magnesia, carbonate of lime, etc.)

From a number of samples bought at different stores, we find that twenty-four out of thirty-three contain ultramarine blue.

There is still another test, and easy to try: that is to add a few drops of acid to a solution of sugar. The olfactories will be the best judge as to the presence or absence of the adulterations. Anyone not acquainted with the delicate (?) odor of sulphuretted hydrogen, will be introduced with pleasure, at the close of the session.

THE PINK AND WHITE TERRACES OF NEW ZEALAND.

BY JOSEPH SAVAGE, LAWRENCE, KAS.

It was during a recent conversation with Prof. F. H. Snow that I first learned that his brother William had spent some 2½ years in New Zealand, in the immediate vicinity of the Pink and White Terraces. The journal which this brother kept while there has been kindly placed in my hands, and from which I will make some extracts which I am sure will interest every member of the Academy. Before reading these extracts I would say by way of preface to them, that the Pink and White Terraces of New Zealand resemble very nearly in form and kind, the terraces found in the Yellowstone National Park, at the White Mountain hot springs on Gardner's river — with this exception: the deposits of the former are silicious, while those of the latter are calcareous. Having seen the Gardner's river terraces myself, and bathed in their tepid waters — and also having seen Mr. Snow and party as they passed through our city on their way to New Zealand, the extracts become doubly interesting to me.

Passing through a 13-mile forest they landed at a native village, from which they started before light in the morning for a nine-mile row in a boat over an inland lake, when, he says: "We were first landed from our canoes at the foot of a white incrustation called the white *terrace*. About 300 or 400 feet inland, and at a gentle incline from the lake, a huge roaring caldron day by day has overflown its sides with a sheet of water, that in trending its way to the lake has denuded itself of its mineral particles and gradually amassed this immense berg of white incrustation.

"Escaping from the caldron, the boiling water, becoming gradually cool, has followed the erratic depressions of the slope to the lakelet, and in imbedding earth, rocks, and fallen trees with its crystalline mites, has formed a succession of broad, irregular terraces.

"These steps and platforms are again fretted and engraved, and in places so immaculately white, they resemble broad tables of the loveliest coral. One could imagine the fingers of Jack Frost had been at work perfecting his most delicate mystic devices. The projecting ends of the terraces are fringed with multitudes of tapering pendants, resembling long rows of icicles, from which trickle continuous rillets of steaming water. At intervals upon the surface of the terraces, Nature has with that delicate art which transcends all human skill, chiseled deep basins that are filled with transparent water, as blue as the heavens above. As you stand on the white-chased edge of one of these blue spotless pools, veiled in the haze of steam which rises from its surface, within view of the placid waters, the steaming islet, and the flocks of native birds of the lake below, and within hearing of the roar and burst of the spouting geyser in the caldron above, your position is truly one that beggars the cunning of human lips.

"Higher and higher we climbed up the intricate ways and irregular steps of apparent coral and glass, till at the summit we reached the brink of the caldron. Here we found a huge bowl of blue water that spurts in the center up into a crashing, deafening fountain, that is hot to an infinite degree beyond the boiling point, and emits a blinding cloud of steam that obscures the heavens. Strange to say, during the prevalence of south winds this great volume of reeking water recedes through a deep, gaping aperture into the bowels of the earth, leaving the bottom of the incrusted crater dry and safe to walk upon. The safety in intrusting oneself within these walls of silica lies in the fact that the return of the mad fountain is preceded by a terrible roar and rumble that no sane person will listen to without being stricken with an immediate desire to change his quarters. In fact, most of the prevailing sounds and symptoms of this region have a decided tendency to render one wary, as

a false step at the right moment would precipitate one into boiling depths that would literally tear you to atoms. The fumes exhaled by the waters of the white terraces are so powerful that birds in attempting to fly over the caldron drop dead upon the terrace. The birds, like ferns and other objects thrown into the shallow, warm water, are quickly incrusted in their natural shapes, and are preserved for years.

"Just in the rear of the White Terrace is what is known as the Burning Mountain, which is honey-combed with small, hot apertures that puff forth a multitude of steam jets to acquaint us with the heated tumult within.

"From the terrace we made our way over a rough, narrow path to a batch of boiling springs and geysers, where we found one of the latter spurting a wild fountain of sparkling jets and spray through thick clouds of smoke up to thirty or forty feet in height. On the opposite side of the path is a rocky-sided spring, that at our arrival was quite calm and noiseless; but upon the subsidence of the big geyser, which is intermittent, this apparently recluse vent burst into a boisterous eruption. A continuance of our walk for a few yards brought us to the boiling hole, now filled with rocks, where a little native boy whose funeral we had attended in Wairoa made his fatal misstep. A little beyond, as we approached another spring available for cooking purposes, the position of the sun, as well as the looseness of my waistcoat, reminded us it was high time to interview the lunch basket. One of our Maoris had anticipated our coming, and immediately produced two kits from the spring filled with nicely-boiled crayfish and potatoes. Seating ourselves upon the heated stones beside the spring, we began operations. Kate's adroit fingers shelled the crayfish faster than we could comfortably dispose of them. In exchange for the potatoes, with their decided flavor of minerals, we were glad to hand over to the natives the greater share of our hotel lunch. A short shower obliged resort to the shelter of a wharl standing close by, which we found almost uncomfortably warm, owing to the heated exhalations through the ground. In this little hut the child who was scalded had lived just before his accident, consequently the building was declared sacred, and soon afterward purposely burned to the ground.

"After our lunch and the shower were over, we again set forth with Kate at our head over the roughest kind of a path a few score rods to the mud flats. Here we found a great number of holes and chaldric pits filled with seething, sputtering and popping masses of clay-colored mud. Here, scattered over the flat, were numbers of mud cones which the fires within had forced up into the shapes of overgrown anthills. Puffs of steam were continually issuing from the summits of these cones, to make them look like miniature volcanoes.

"Threading our way past these huge pots of boiling mud, and by the numerous hardened cones, we came to a large pool of water so very green in in color that we at once thought it to be in the worst state of stagnation. But to our surprise when we arrived at the brink, we found it as clear and crystalline as a mountain pond. Its mineral impregnations gave to it the vivid cast of green; strange to say, the water of the little pond is quite cold—although but a few yards distant from the mud flat with its many evidences of intense subterranean heat.

"The next in the order of sights, and the most diabolical of all the countless phenomena of the region, is an infuriated pit of steam ten feet in diameter, called the Devil's Hole. From this raging, roaring, bellowing vent, a deafening tempest of steam is debouched high into the heavens, with the burst and noise of the explosion of a thousand escape-valves. One could almost imagine all the malevolent spirits of the infernal regions were belching forth their most furious tempest blasts. In approaching the hole, Kate cautioned us to keep within the path which led over a hollow flat peppered with a million minute and sizzling perforations. In places the

earth fairly quivered beside the path, suggesting to us that a few missteps might incur a rapid transit down through to some foreign country, with a chance of bringing up rather demolished.

"Leaving this bellowing trombone of the fire giants of the inner realms, we came to a much smaller vent in the rocks, with a gush of steam making as much hubbub as its size could possibly warrant. This aperture is as delicately christened as the arger one, being called the "Pain in the Belly."

"Then Kate led us down a steep, treacherous-looking path to a large, cruel spring called 'Reea Kiwi.' It takes its name from that of a little girl who, with an infant on her back, went to the spring, we were told, to put a kit of potatoes in at the side. Both children were soon found in the water, literally boiled to death. Near the Reea Kiwi is a cave in the rocks where a native chief lived and died in the midst of sulphur fumes, and surrounded by the roar and rumble of the thermal caldrons.

"Although I have neglected to write of scores of scenes we have passed in this wonder-region, they are still far from exhausted.

"Kate next escorted us back to the canoe, where reclined lazily our boatman upon the bed of tea-tea she had so thoughtfully arranged for us. We were then paddled swiftly but noiselessly across the half-mile of lake to the foot of the *Pink Terraces*. These, like the White Terraces, are composed of mineral deposits distributed in sedimentary mites over the irregularities of a steep decline from a huge caldron to the lake below. In size the Pink Terraces are somewhat less gigantic than the White, and instead of the appearance of florescent coral, they resemble huge banks and projecting tables of the purest marble. In color they are in some places spotless white, and in others light gray, threaded here and there with veins of the brightest pink. The caldron at the top is partly covered with and wholly surrounded by a thin shelf of white mineral deposits. This shelf is rimmed with a margin of sulphur as yellow as gold, contrasting with the exquisite blue of the water, which is so clear, so transparent and crystalline, that the minutest objects are visible many feet in depth. The verdure of the banks, in the rear of the caldron, is held in the lap of modest, gently-shading hills, overlooking a scene that may challenge the world to produce its counterpart. Then there are those cups and basins that are cleft in the flats of apparent marble between the huge steep steps, filled with water — blue, warm, and so luxurious, that you are seized with the desire to drop your wardrobe for a swim."

The delicious bath was taken, going from the lower pools up towards the boiling caldron until the goose-pimples stand out upon the body till it resembles a boiled lobster. The natives during stormy days resort to the hot springs, and lie immersed in the tepid water, with nothing but their black heads appearing above the surface, remaining in them whole days at one time.

Mr. Snow called a congress of these ex-cannibals, and they told him of their former ways of living, killing their enemies and afterwards eating them; all of which we will omit, except this: That white men and sliced missionary were too salty for their taste. Natives were much preferred.

After a residence of two and one half years among this people, laboring among them as a temperance missionary, Mr. Snow's health failed, and he set sail for Gernany and died while on shipboard. After his death his mother went on to New Zealand to continue the work so nobly begun by her son. She remained there about one year, and built a meeting-house — or temperance hall, as it was called — for the natives, as a sort of memorial gift in memory of her son.

During her stay there she lived in the family of a Mr. Hazzard, an Englishman, who with his family was teaching a native school in the vicinity of the terraces.

This hot-spring district seems to have been on a native reservation, and all the Europeans there were these teachers and a few hotel-keepers, and a constant flow of

tourists from all countries, who came there to see the terraces and other volcanic phenomena of the district.

On the evening of June 10 of the present year (1887), a volcanic eruption consisting of lava and thick mud destroyed the Pink and White Terraces and the native village where the school-house, the temperance hall and the hotels were situated. Besides nearly one hundred natives who lost their lives in this overflow, there were six Europeans who also perished, including three of the Haggard family — the father and two children. The following account of the eruption, written by Miss Clara Haggard, will no doubt be interesting in this connection. She says:

"We were all in bed by eleven o'clock. At 1:15 I was awakened by a rumbling noise, and father asked me if I felt the earthquake. I said yes; and it kept on a long time. Mr. Blythe was also awakened, and father said, 'It is the most wonderful sight I have ever seen,' and we all went out on the veranda to see it. There was a large, inky-black cloud hovering over the truncated cone of Tarawera, with lightning and balls of fire shooting out of it. Mr. Blythe said it was a cloud charged with electricity. We all dressed and went into the sitting-room, thinking it was the safest part of the building, as it was constructed of corrugated iron. We lighted a fire in the stove, and mother sat down in the middle of the room with all the children around her. Looking out of the window, it was like a great sheet of fire. I sat down at the organ and played and sang hymns.

"At 3 o'clock we heard a rattling as if stones were falling on the roof of the house. The noise was so great that we could not hear each other speak. We afterward found it to be caused by falling lava. When that came on, father went out into the middle of the room, leaning on mother's chair. Mr. Lundins picked up a piece of lava, when we all came to the conclusion that Tarawera had broken out in an eruption. The volcanic shower continued to pour on the house for about an hour.

"A tremendous gale of wind arose, and then came down the chimney with such force that we were nearly suffocated with the smoke, and had to cover the stove with a mat, and pour all the water we could get on it. At about 4 o'clock, we were all, except Messrs. Blythe and Lundins, assembled in the middle of the room, believing that to be the safest place, as the walls were bulging and threatening to come in. I walked over to the door (seeing it bulging), to lean against. I found Blythe and Lundins standing at the same place, when suddenly there came a tremendous crash, and all was dark — the roof falling on top of us. I put out my hands and grasped, instinctively, Mr. Blythe's hand on one side, and Mr. Lundins' on the other, for protection. Mr. Lundins jumped up and smashed the window, cutting his hand very much. Finding he could not do as well with his hand, he used his foot, and got out. He then said, 'I'm out — come out, Miss Haggard;' and he pulled me out. Mr. Blythe followed, but on getting into the open air, we were struck about the head and body by lumps of lava. We shut the door, but finding the roof bulging down, and being unable to get into some of the rooms, we opened the door and stood in the doorway, so as to be ready to escape. I was perishing with cold, and Mr. Blythe got some blankets to protect me from the cold.

"Just then, the house appeared to be struck with lightning and burning lava, and it took fire. We all rushed out into the garden to find shelter, and got into the paddocks, after stumbling over some uprooted trees in the darkness. Seeing by the light of the burning apartment that the hen-house was still standing, we went there for shelter, and remained there till daylight watching the principal buildings burning. We waited there in great anxiety, being under the apprehension that all the house was on fire, but we found afterward that the corrugated-iron building remained untouched, owing to the quantity of volcanic mud around and above it.

"When daylight arrived, Mr. MacRae and the two Birds, his brothers-in-law, ca

up from the hotel to see how we had fared, and we all went down to the corrugated-iron portion of the dwelling-house to see about the rest, and found a Maori woman — old Mary of the Mu — and my sister Ina. It appears that when the building fell in, old Mary snatched my sister into the bedroom, and they crawled under the wash-stand; after a while, finding no more mud fell on them, they endeavored to push away the stuff that was covering them. In this they succeeded, and raised themselves upright, awaiting their fate, and continued there in the dark until 6:30 o'clock in the morning.

"At daylight we were reunited by Mr. Lundins breaking the window and getting the native woman and my sister out.

"The whole party, including Mr. MacRae's people, listened for any sound to show that any of the rest of the family were alive in the collapsed corrugated-iron building; but hearing no sound, and seeing at least 8½ feet of mud on the debris of the fallen roof, we all went down towards the lower village where we found everybody leaving the settlement."

Upon further examining the ruins of the building, it was found that Mr. Haggard and two of the children were dead, and that Mrs. Haggard was severely injured — a baby which she held in her arms being one of the dead.

To every reflecting mind, this account of the destruction of the Pink and White Terraces, so nearly akin to our own in the National Park, suggests the thought that some day the same fate may befall them. The general accepted theory that the volcanic forces of the earth are dying out, does not receive confirmation by the renewed activity of the last few months. The Japanese eruption a short time ago, and the one herein described, and later and nearer home, at Charleston, would rather indicate that this old accepted theory might, with due respect to things ancient, be reconsidered if not entirely reversed.

THE TWENTY-FIRST ANNUAL MEETING.

TRANSACTIONS.

THE twenty-first annual meeting of the Kansas Academy of Science was held in the Board of Trade rooms in the city of Leavenworth, beginning on the evening of October 31, 1888, and continuing through the two days following.

The first evening session was devoted to an exhibition of microscopes and microscopic work; and the display of instruments and specimens was large and creditable.

The evening of November 1 was given to a lecture by Mr. Robert Hay, upon "The Geology of Kansas." An abstract of this lecture appears in the following pages.

The annual election of officers resulted in the choice of the following members for the offices named: President, T. H. Dinsmore, Jr.; Vice Presidents, E. H. S. Bailey, G. H. Failyer; Secretary, E. A. Popenoe; Treasurer, I. D. Graham; Librarian, B. B. Smyth; Curators, A. H. Thompson, V. L. Kellogg, H. W. Birchmore, Robert Hay, and E. A. Kilian. Fifteen names were added to the roll of active members.

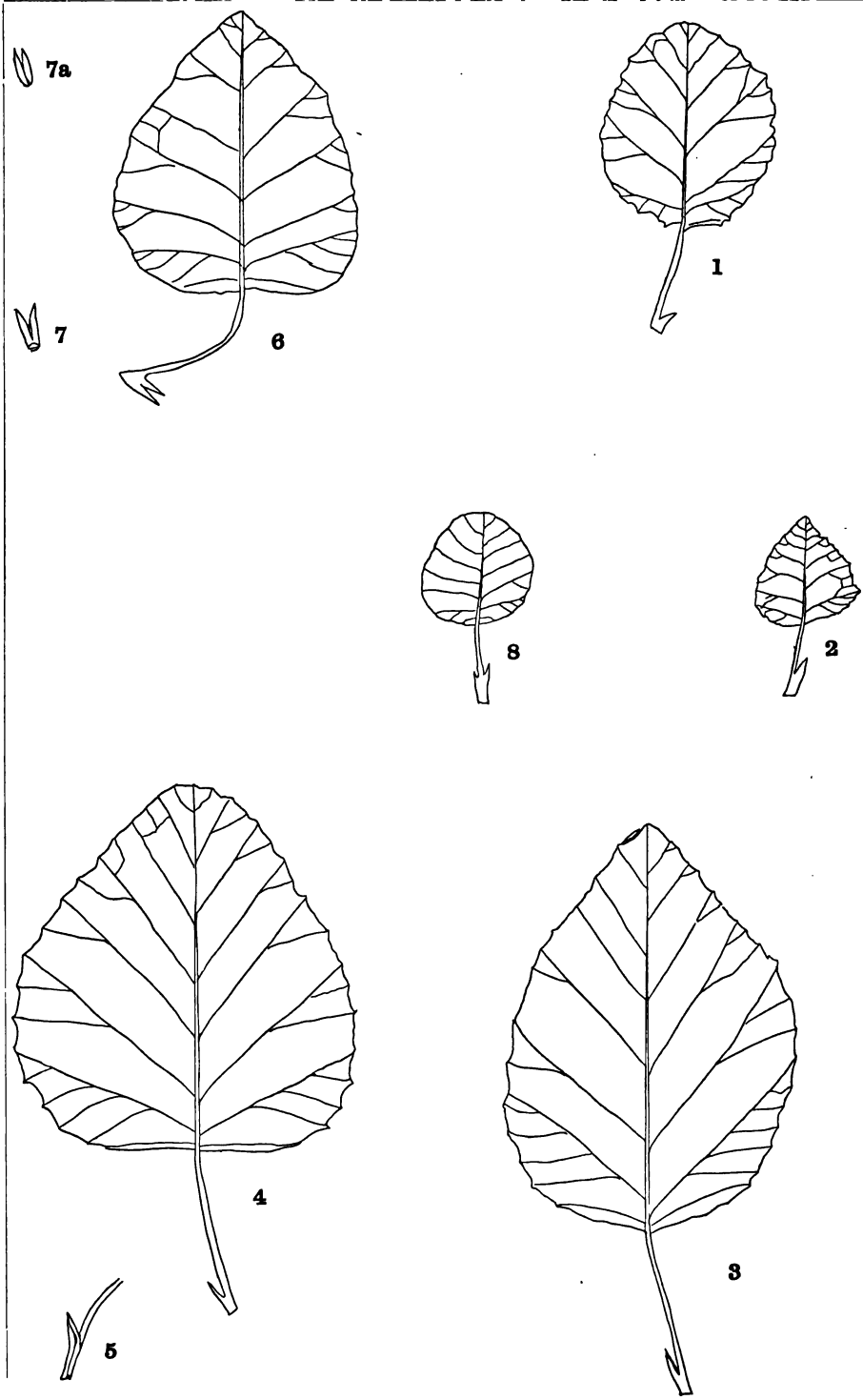
At the sessions of this meeting were read, among others, the following papers:

ON THE DISCOVERY AND SIGNIFICANCE OF STIPULES IN CERTAIN DICOTYLEDONOUS LEAVES OF THE DAKOTA ROCKS.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

At the last meeting of this Academy, I presented a paper upon the species of fossil leaves of the Kansas Dakota rocks represented in the museum of the University of Kansas. The list of plants accompanying that paper included upwards of one hundred species new to science. One of these species, of the new genus *Betulites*, according to Lesquereux, but referable to *Viburnum* according to Saporta, is named by Lesquereux *Betulites Vestii*, in honor of the indefatigable collector of these fossils, Mr. E. P. West, whose remarkable success has made the University collection of Dakota fossils the largest and finest in the world. This species of *Betulites* is represented in our collection by no less than twelve distinct varieties, each of which has been indicated by a separate name by Lesquereux. A large proportion of the specimens of this very variable species are found to be provided with stipules, which leaf appendages were not previously known to be connected with the Dakota leaves. These stipules instead of being uniformly in pairs, one upon each side of the base of the petiole, as is the case in living Dicotyledons provided with these appendages, are either single, in which case they may be entire, cleft or parted, or they are, in occasional instances, entirely divided, constituting a pair of stipules. But whether single or divided, they are nearly always unilateral, *i. e.*, situated upon one side of the leaf stem or petiole. In only one instance among at least one hundred stipulate leaves examined are the stipules bilateral, so that their unilateral character fairly distinguishes them from the stipules of modern Dicotyledons.

The significance of the discovery of these cretaceous stipules, lies in the fact that we have here an additional proof of the descent of our modern forms of vegetation from the ancient forms by a gradual series of changes. To the superficial ob-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server it would seem that our modern forest leaves are absolutely identical with the cretaceous leaves, which, according to Dana's time ratios, flourished about five million years ago. The opponents of the modern theory of origin of species by descent have derived a strong argument from the apparent identity of the modern with the ancient forms. But the identity is apparent only; not real. Lesquereux has noted the fact that the Dakota leaves, as a rule, have entire borders, while the modern forms of the same genera have denticulated or serrated borders. Another difference between the modern and the Dakota leaves consists in the greater thickness and toughness, or, in botanical language, the coriaceous character of the ancient forms. But in the stipules of the Dakota leaves, we not only have a prevailing unilateral position of these organs, as distinguished from their modern bilateral arrangement, but we are able to witness the gradual change from the single undivided form through the successive steps of transformation to the completely separated and finally bilateral pair; each stage of differentiation being indelibly stereotyped upon the sandstone matrix by which the leaves are enveloped.

The accompanying plate will show the chief stages in the development of these organs.

EXPLANATION OF PLATE.

FIGURE 1. Betulites Vestii, Lesqx., var. Obtusa, Lesqx., showing unilateral stipule.

FIG. 2. Betulites Vestii, Lesqx., var. Inæquilateralis, Lesqx., showing another form of unilateral stipule.

FIG. 3. Viburnum Dakotense, Lesqx., var. Longifolia, Lesqx., showing unilateral stipule.

FIG. 4. Viburnum Dakotense, Lesqx., var. Ovatifolia, Lesqx., showing a narrower unilateral stipule.

FIG. 5. A detached unilateral stipule and part of petiole, showing the groove in the stipule.

FIG. 6. Betulites Vestii, Lesqx., var. Latifolia, Lesqx., showing bifurcated unilateral stipule.

FIG. 7. Detached bifurcated unilateral stipule, showing the base of the petiole.

FIG. 7*a*. Opposite side of 7, the stipule itself showing the groove on which the line of division takes place.

FIG. 8. Betulites Vestii, Lesqx., var. Subintegrifolia, Lesqx., showing bilateral stipules, or the bifurcated unilateral stipule completely divided and arranged on both sides of the petiole.

LECTURE.—THE GEOLOGY OF KANSAS.

[The second night of the session was occupied by a lecture on "The Geology of Kansas," by Prof. R. Hay, Junction City. This was given in the auditorium of the High School. It was illustrated by geological sections, a map, and many specimens. The following is a brief abstract of the address:]

"Something has been known of the geology of Kansas from the date of the earliest settlement. In the years 1855–8 there was a controversy as to who had the honor of first saying that certain formations were of Permian age. The Carboniferous age of rocks in eastern Kansas had already been recognized."

The lecturer then gave some account of his own work, and the methods of geological investigation, and the relation of the geology to the topography of the State; and then came a succinct account of the succession of formations, from the lowest (in Kansas), the Sub-Carboniferous of the southeast, to the tertiary of the west, and the quaternary deposits of large areas in all parts of the State. The use of the term Permo-Carboniferous was explained and vindicated; and the *erosive unconformity* of the lowest Cretaceous (Dacotah) on the Permo-Carboniferous in middle-northern Kansas was clearly described; and then followed an account of the position of the Triassic rocks and salt-beds of the southern part of the State. This is a new thing in the geology of the State, and of it the lecturer said, after an illustration of the above-named erosive unconformity:

"This, on comparison with other parts of our country and Europe, shows an

omission of the Triassic and Jurassic groups, so that northern Kansas was probably dry land during the time elsewhere used for the deposit of those series of formations. Probably in that time the great valleys of eastern Kansas began to be eroded."

"In southern Kansas there is seen no such contact between the Cretaceous and the Permian. In going west from Winfield and Wellington, after the last of the Permian rocks have been seen, crossing the sandy depression that constitutes the valley of the Chikaskia we see rocks of a new kind. Not Cretaceous, not Permian —but red Arenaceous limestones, red, hard shales, red clays, with thin layers of a lighter color—greenish, grayish, or white. These spread out into the cañoned formations of the Gypsum Hills, where these red rocks have a cap of white gypsum for many miles. These, like the Permo-Carboniferous rocks, have a slight westerly dip, and in Barber and Comanche counties an exposed thickness of about 500 feet. Their depth below the surface and upward increment westward make them have not less than ten or eleven hundred feet of total thickness, lessened in many places by great erosion.

"These—red-beds—are well developed in Kingman county, but disappear to the north under the deposits of the Arkansas valley—fifty to 60 feet at north Hutchinson, 140 feet at Sterling—and the high prairie beyond, to reappear, so far as observed, in only two or three limited localities in the north of McPherson county, near the southern bow of the Smoky river. Besides the borings at Hutchinson and Sterling, those at Nickerson and Lyons show the red-beds to be below the surface. At Lyons and Ellsworth, the Dacotah formations are above them; and in Harper, Barber and Kingman counties, limited areas show the same thing in depressions. But in these places, it is only the upper part of the Dacotah. The salt wells at Ellsworth show the red-beds thinner than at Hutchinson, and those at the latter place are thinner than at Kingman, and at Kingman thinner than at Anthony. The red-beds thin out northerly. The Dacotah thins out southerly. These red-beds we call Triassic, but possibly the upper part may be Jurassic. As yet they have yielded no determined fossils in Kansas."

"At the bottom of the red-beds, and as we think, continuous upward into them and continuous downward into the Permian, are three or four hundred feet of saliferous shales, and intercalated with them the beds of rock salt which have recently become so noted. The salt-beds vary from five to one-hundred feet in thickness, and the shales themselves are strongly impregnated. The water poured down the Hutchinson wells and pumped, immediately comes up a saturated solution: a salt brine so pure that it needs no manipulation, but goes straight from the tank to the evaporating-pan."

With regard to the increase of our knowledge of the Tertiary formations, the lecturer said:

"Eleven years ago, Prof. Kedzie wrote: 'The separation between the Cretaceous and Tertiary formations, though clearly defined, is hardly a sharply-traced line, but rather a stretch of country thirty miles wide, extending across the country from Nebraska to Colorado. Within this band may be found the formations of both periods: the Cretaceous in the low valleys, and the Tertiary upon the high hills.' While this passage represented accurately the knowledge of these formations in Kansas at that time, yet, taken with its accompanying map, it shows to us now the deficiencies of that knowledge. The 'band,' which is to some extent properly described, is much more than one hundred miles wide instead of thirty, and instead of running off to Colorado north of the Smoky river, it crosses the Indian Territory, the Cretaceous outcrop to Colorado being confined to the two great valleys, and possibly that of the Cimarron. The presence of the Tertiaries in the valleys, telling their tale of erosion, was entirely overlooked.

"The Tertiary deposits overlap all the Cretaceous formations—Niobrara, Benton, Dacotah. In McPherson county, and south of the Arkansas, they are seen on the Triassic. In Marion and Sedgwick counties, they rest on the upper beds of the Permian—in the latter case coming east of the sixth principal meridian. A more thorough study of the position of the Tertiary deposits will reveal some intensely interesting facts as to the age of the erosion of our great valleys."

After some interesting statements about the glacial phenomena of northeastern Kansas and the superficial deposits of later times, the lecturer stated that economic geology has had much development, and that Kansas has not only metals and building-stones, but that stones—agates and jasper—are being found, of great value for ornamental purposes; and concluded as follows:

"There is a certain relation between gypsum and saline deposits. Owing to possible subsequent changes and omissions, we cannot always infer the existence of one from the presence of the other; but there is evidence of a cumulative character which we think points towards the discovery of another salt horizon of more recent formation than that now so successfully worked." . . . "In conclusion, we may express the desire that this audience will use means to influence legislators to cause a survey to be made of this State, which will aid in developing our resources, and help to bring scientific problems to a correct solution."

GEOLOGY OF THE LEAVENWORTH PROSPECT WELL.

BY E. JAMESON, LEAVENWORTH, KAS.

Mr. President, Ladies and Gentlemen: For some years, one of your members, a respected citizen of Leavenworth, has been preaching to us that there were both gas and oil under this city. One by one we became converted to his views, until Mayor Neely in 1887 prepared a bill, and had it presented and passed by the Legislature, authorizing this city to vote ten thousand dollars in bonds, to be spent in prospecting for gas. The City Council let the contract to Mr. Reed, an expert from Pennsylvania, and on the 17th day of October, 1887, the drill commenced to make its way through the rocks with the intention of reaching a depth of 3,000 feet, which the contract called for.

The Leavenworth coal mine is down to a depth of 1,100 feet, so that we knew the strata to that depth. At 550 feet the regular flow of salt water was struck, which has been found in all the mines. At 1,150 a very strong flow of salt water was struck. These two streams were shut off with casing, and in the next 600 feet five streams of water were struck, which flowed to within 100 feet of the top of the wall. At 1,700 feet a strong flow of sulphur water was struck—so strong, indeed, that it destroyed 500 feet of the hemp cable. On April 7th, 1888, at 1,802 feet, a new stratum of rock was reached, and when the drill was lifted the rope was saturated with petroleum, and so reported by Mr. Reed to Mayor Neely and myself. Steps were at once taken to shut off the water. This was found impossible; neither casing, patent stoppers nor seed-bags would shut off the immense flow. After careful consideration it was thought best to go further down, and when a hard rock was struck, to shut off the water. For the next 300 feet the rock was porous. The sand taken out was examined by experts, and pronounced to be oil-bearing rock of the very best kind, They all agreed, however, that the well was a failure, on account of the immense quantity of water.

There is no doubt gas was found in small quantities, for when the well was agi-

tated with the sand pump, the water would flow over the top of it for several minutes at a time.

At 2,106 feet it was found impossible to drill any further. The water was so strong that the drill, which weighs three tons, floated with the hemp cable, and made no impression on the rock; 2,106 feet of casing were put into the well, with a patent stopper and a seed-bag, but the water could not be shut off. A pump was then tried, and for a week—day and night—200 gallons of water per minute were lifted out of the well. At the end of that time it was found that the depth of water had not been reduced five feet.

The water taken from the well was effervescent and hot. Gallons of it were taken away by people to be used as a medicine. Dr. Brown and other experts say that it contains very valuable properties.

I visited the well once, and sometimes twice, every day, from the time it was started until the finish, and the following is a list of the strata passed through, as furnished me by Mr. Reed:

	Depth of strata.	*Total.*		*Depth of strata.*	*Total.*
Loam and clay	20		White sand-rock	30	895
Shale	10	30	Gray shale	10	905
Limestone	40	70	Dark hard sand-rock	15	920
Shale	25	95	Gray shale	30	950
Limestone	20	115	Dark sand-rock	18	968
Shale and limestone	75	190	Black shale	20	988
Hard limestone	20	210	Coal	2	990
Shale and limestone	140	350	Fire-clay	10	1,000
Hard limestone	20	370	Sharp white sand-rock	40	1,040
White shale	35	405	Dark shale	20	1,060
Dark sand-rock	15	420	White sand-rock	10	1,070
Shale	135	555	Dark shale	20	1,090
Limestone	5	560	Dark sand-rock	15	1,105
Shale	25	585	Soft black shale	40	1,145
Limestone	10	595	Hard gray sand-rock	25	1,170
Shale	25	620	Black shale	5	1,175
Sand-rock	5	625	Hard white sand-rock	375	1,550
Shale	50	675	Brown limestone	20	1,570
Sand-rock	3	678	Iron pyrites	5	1,575
Shale	10	688	White shale	75	1,650
Sand-rock	5	693	Brown limestone	30	1,680
Shale	27	720	Light-gray limestone	30	1,710
Coal	2	722	Hard gray sand-rock	102	1,812
Clay and shale	25	747	Soft sharp sand-rock	18	1,830
Coal	2	749	White pebble sand-rock	40	1,870
Fireclay and shale	81	830	Hard white rock	50	1,920
Dark sand-rock	15	845	Soft blue sand-r'k, turning white,	90	2,010
White shale	20	865	Lower Helderburg limstone	106	2,116

In my opinion both oil and gas will be found near Leavenworth. With our present experience, and the information we have gained, the water could be cut off in another well, at 1,800 feet. The rock was very hard, and if the water had been shut off then—which it could have been—the well would have been a success. Our people, while disappointed, are not discouraged, and I believe the day will come when we will make another ventnre with more success.

THE TRIASSIC ROCKS OF KANSAS.

BY ROBERT HAY, JUNCTION CITY.

[*Abstract.*]

In this paper the writer gave at greater length a description of the triangular region whose base stretches on the southern State line from east of Caldwell to west

of Ashland, and whose apex is in the northern part of Kingman county, than was given in the lecture of the preceding evening. He also inferred from the borings at Salina, Ellsworth and Russell, that the triangular form was continued in the subterranean development of the red-beds, and that Ellsworth was within, but near the apex of it. The main feature of the paper, in which its scientific bearing is of great importance, was the statement, also made in the lecture of the previous evening, that the saliferous shales and beds of rock salt which lie beneath the Triassic red-beds were continuous downward with them, and also were continued down without break into the Permo-Carboniferous formations. That is, that in southern Kansas—and presumably in the Indian country beyond—there is no break from Paleozoic to Mezozoic time.

This is not abtolutely affirmed, but the writer believes that the great mass of the evidence so far tends that way.

NOTE.—Just before this goes to press, the writer has made other observations in Kingman and Sumner counties, and finds outcrop of the red-beds six miles west of Wellington, and the proof more positive that they are continuous with the grayer shales below, and that these shales, extending to and beyond Wellington, all belong to the saliferous horizon.—R. H.

THE LOGAN COUNTY NICKEL MINES.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

While engaged in collecting specimens of Natural History in Wallace and Logan counties in August, 1888, I learned that considerable excitement had been produced in the central portion of the latter county by the discovery of valuable metallic ores. The first reports specified silver as occurring in paying quantities in that region, but later advices substituted nickel for silver, without any abatement of the popular excitement. I lost little time in making my way to the scene of commotion, and found the center of the new mining region in the southwest quarter of section 2, township 14, range 46, west of the 6th principal meridian. This quarter-section is three miles south of the Smoky Hill river, eight and one-half miles distant from Russell Springs, the county seat of Logan county, fifteen miles a little west of south from Winona, and eighteen miles a little south of east from Wallace, the county seat of Wallace county. It is about forty-five miles east of the western boundary, and seventy-five miles south of the northern boundary of the State of Kansas. Upon reaching this locality, I found that although less than two weeks had elapsed since the announcement was first made of the discovery of these mineral deposits, more than 400 acres of ground had been staked off for mining claims, and the excitement was becoming more intense every day. Hundreds of people were coming and going, and the once peaceful prairie had suddenly assumed the boisterous character of a genuine mining camp. The nomenclature of the claims indicates that Kansas can vie with Colorado and Arizona in the use of expressive language. The following are the names by which some of the prospect holes have been christened: Western Chief, Nickel King, Nickel Queen, Eli, Jimmie, Eureka, Nickel Cañon, etc.

Values of these mining claims had not found a definite basis; $20,000 was reported to have been offered and refused for the two best claims, and five hundred dollars had been indignantly rejected for a half-interest in a less promising mine.

I was especially interested in visiting this spot because in former years, in company with Professor Mudge, and subsequently with parties of University students, I had explored the rocks in the immediate vicinity in search of vertebrate fossils. It was within twenty-five miles of this locality that in 1878 I had the good fortune to discover the now famous saurian, whose remains are so perfectly preserved that even

the dermal scales upon the abdomen are as accurately outlined as are those of living reptiles. Only six miles north of this spot we obtained during the same vacation a saurian whose jaws, nearly three feet in length, were just protruding from the blue shale, under such circumstances as to indicate that there had been no serious disturbance of the rock-strata during the millions of years which must have elapsed since the reptile gave up its life. It was within a few miles of this spot that Professor Mudge obtained the most perfect specimens of fossil birds which have ever been discovered; birds with teeth in their jaws, which have furnished the material for the great work on Toothed Birds (*Odontornithes*) by Prof. Marsh of Yale College. Having been thus familiar with this region as a paradise for fossil hunters, I was anxious to ascertain if it were possible that some local disturbance had produced metamorphic changes resulting in the formation of metallic ores. In Woodson county a square mile of the carboniferous rocks has thus been metamorphosed to an unknown depth, the disturbing forces having transformed into crystalline rocks the original fragmentary rocks, thus producing some of the conditions under which metallic deposits are found in mountainous regions. A great silver excitement was produced in that country about twelve years ago, having for its center this limited area of crystalline rocks. The chemists found faint traces of silver in their analysis of this material, and the entire area was honeycombed by the excavations of prospectors and miners, who gathered from near and from far, with the expectation of striking a bonanza. Thousands of dollars were expended in the vain attempt to extract the precious metals from rocks which had been declared by our best geologists and chemists to be of no actual value for mining purposes. It is true that a trace of silver was detected in these rocks. There are also traces of silver and gold in the waters of the ocean, and we are told that the total amount of these precious metals thus held in solution would be sufficient to make every human being rich if they could be separated from the containing waters by some inexpensive process. There are undoubtedly minute quantities of gold and silver in all our Kansas rocks, from the sub-carboniferous deposits of the southeast to the tertiary deposits of the northwest. A Denver chemist reported a trace of gold and a small amount of silver ($2.50 to the ton) in the rocks of Logan county. But any attempt to extract these metals from Kansas rocks seems as impracticable as would be the attempt to separate them from the waters of the ocean.

A careful examination of the rocks now being mined for nickel in Logan county reveals no evidence of metamorphic action. There is an entire absence of crystalline rocks. The so-called "nickel ore" is the prevailing fragmental rock of the Tertiary age, the characteristic conglomerate or pudding-stone which overlies the eroded surface of the Niobrara limestones and shales. The color of this rock at the "mines" is darker than that of the ordinary conglomerate, but it is unmistakably the same kind of rock. A chemical analysis of specimens of these rocks by Prof. E. H. S. Bailey reveals the presence of nickel and cobalt in very small quantities. A special examination of one specimen, said to be among the richest, showed not more than one-third of one per cent. of cobalt, and one-tenth of one per cent. of nickel. The specimens used for this analysis were of my own selection from the two mines considered to produce the most valuable ore.

It may be here stated that the lowest grade of nickel ore as yet found profitable for treatment is mined in large quantities at Lancaster Gap, Penn., and contains from 1½ to 2 per cent. of nickel. But this ore, in order to merit transportation to the refining works at Camden, N. J., must first be reduced at the mines to a more concentrated form by being smelted into a "matte" containing 10 per cent. of nickel. Thus the Logan county rocks, according to Prof. E. H. S. Bailey's analysis, con-

tain only from one-fifteenth to one-twentieth the amount of nickel present in the lowest grade ores yet subjected to profitable treatment.

I made a second visit to this locality Oct. 20th, for the express purpose of making a more thorough search for evidence of metamorphic action. But no such evidence could be discovered, and the conclusions made after my first visit were confirmed by the second. There is no change of limestone to marble, of shales to schist, or of sandstone and conglomerate to chert. The so-called "ore" lies at or near the bottom of the Tertiary strata, just at or above their contact with the Niobrara section of the cretaceous formation. The characteristic fossils of the Niobrara rocks are abundant in the immediate vicinity, entirely unaltered by metamorphic action. Within ten rods of the Nickel Queen mine I found an unusually perfect valve of the large mollusk of the genus *Haploscapha*. Within half a mile of this mine were abundant vertebræ of the common cretaceous fish *Portheus molossus*, with occasionally a saurian vertebra. Metamorphic action such as seems necessary for the formation of valuable metallic ores would have obliterated these fossils in rocks so nearly adjacent to the ore-beds.

As bearing upon the question whether the geologist has the right to expect nickel ores in Kansas, it will be necessary to consider the location of these ores in other regions. So far as I have been able to ascertain, they occur without exception in the crystalline or metamorphic rocks, where there has been a conspicuous displacement of the strata from their original horizontal position, with evidences of their having been subjected to great pressure, and consequent high temperature. They also occur in the oldest crystalline rocks rather than in those of a later formation. Almost without exception they are located in the Archæan rocks, and without exception where the strata have been upheaved in mountain elevations. They occur in moderate quantity, in close association with chrome ores, in the serpentine rocks from Canada to Maryland. They are generally diffused throughout the magnesium rocks of the Quebec group in Canada. They are found in the serpentines of Cornwall, the Vosges and Mt. Rosa, and in the primitive schists of Norway. Mr. W. P. Blake, contributing to the volume of the U. S. Geological Survey upon the mineral resources of the United States, states that the most available ore of nickel, and the only one worked up to this date in the United States, is the sulphide, occurring in connection with the iron pyrites. This is an ore which occurs at many places along the lines of the older or Archæan rocks, being found with beds of pyrrhotite (or magnetic iron) from Canada southward. At Chatham, Conn., the nickel and cobalt ores occur in mica schist. There are small quantities of nickel at other places in ancient schists of Connecticut. The nickel ore of Thunder Bay, on the north shore of Lake Superior, is associated with native silver, and occurs in a vein traversing Huronian talcose slates.

The newly discovered deposits of nickel ore in Oregon, containing from 20 to 30 per cent. of nickel oxide, are found in serpentine with chromite and steatite. The ore of New Caledonia, averaging 18 per cent. of nickel oxide (Garnierite), occurs in veins within serpentine. The richness and abundance of these ores, and the ease with which they are smelted, has lowered the price of nickel and driven many of the poorer ores from the market.

It would therefore appear that geological considerations are unfavorable to the existence of valuable nickel ore in the State of Kansas. There are no Archæan rocks in Logan county — no crystalline rocks, and no veins containing metallic ores. The minute quantities of nickel and cobalt indicated by Professor Bailey's analysis may perhaps be accounted for by the fact that these metals, in very minute quantities, are universally disseminated over the surface of the earth, in the meteoric dust which is constantly falling through the atmosphere. According to Professor H. A. Newton,

of Yale College, no less than twenty millions of meteors enter the earth's atmosphere each twenty-four hours, many of these reaching the earth's surface as the finest of meteoric dust. This dust, which like the Logan county rocks contains nickel and cobalt and iron and manganese and other chemical elements, has been found to cover the roofs of the houses of the city of Quito in South America after an unusual meteoric display. It has been found universally present in the ice and snow of the Alpine and Arctic regions. It may be collected at any time from the atmosphere by exposing to the air a properly prepared surface, as was done by Tissandier. It was dredged from the bottom of the deepest Atlantic ocean by the Challenger expedition. There is no doubt that the old Tertiary ocean of western Kansas received this meteoric dust as do the oceans of the present time. If the mud and sand and pebbles of our Atlantic should ever become hardened into rock, and form a part of the dry land, the chemists of that time would be able to detect the nickel and cobalt dust, whose meteoric origin has been established by our chemists and meteorologists. We are now applying the same test to the bottom of the old Tertiary ocean, now a part of the dry land, and find convincing evidence that then as now the atmosphere was traversed by multitudes of meteoric bodies producing the same effect as they now produce. This disintegrated meteoric matter sinking to the bottom of the ocean then as now, would be distributed by the under-currents and lodged in cavities and depressions of the ocean-bottom according to its specific gravity. Such a depression or basin seems to have been struck by the Logan county miners. But these deposits are not suitable for mining, for the quantity of nickel-dust is too small to warrant the expectation of any returns upon the money invested.

THE EVAPORATIVE POWER OF KANSAS COALS.

BY LUCIEN I. BLAKE, LAWRENCE, KANSAS.

The commercial value of coal is not a criterion of its actual heating power. The cost of mining, distance from market, competition, etc., determine the former, while the latter depends solely upon the coal *per se*. Further, the *total* amount of heat obtained by the complete combustion of a given amount of coal exceeds largely — often by fully 100 per cent. — the amount usefully obtained in practice. Confining ourselves to coal used in the production of steam, this is due to imperfect combustion, to arrangement of grate and heating surface, methods of firing, etc., etc. The same coal in different furnaces may give different results. Duty tests upon any one plant give the relative values of coals for that plant only. There is, however, an important method of comparing the actual heating values of coals which is independent of commercial values and of diversified conditions of burning. It is by measuring the heat given out by coals *under perfect combustion* expressed in terms of their evaporative powers. To this end, therefore, it is quite customary to compare coals according to their evaporative powers. By this is meant how many pounds or kilograms of water at 212° F. will be converted into steam, also at 212°, and under 760 mm. pressure, by one pound or one kilogram of coal. The object of the present investigation is to compare coals from the different Kansas veins according to their evaporative powers as defined above.

It might be mentioned that this investigation has been undertaken in conjunction with E. H. S. Bailey, Professor of Chemistry at the State University, who will make report upon the chemical analysis of the same specimens of coal. Both investigations are preliminary to a report to the State Board of Agriculture. The coals for testing have been collected personally by one or both of us at the mines. A va-

riety of average samples was taken from various parts of a mine—block, nut, and slack. These were mixed together and finely powdered. The resulting four or five pounds were considered a fair representative of the coal from that mine, and also had not been selected by interested parties. The burnings were made by Thompson's calorimetric method. The apparatus was constructed by Alex. Wright, of London, and is the one employed by the English Government in the purchase of its coals for railway and marine, as well as by many of the large manufacturers in that and in this country. It is based upon the following principles. The latent heat of water represents the amount of heat which disappears when water at 212° is converted into steam at 212°. This amount is 537.22 gram-degrees or calories. Consequently the number of degrees C. through which 1 gram of coal will raise 537.22 grams of water will be a measure of the evaporative power of that coal. Evidently the absolute value of the latent heat of water is immaterial. The apparatus is arranged to produce the complete combustion of 2 grams of coal in 1,934 grams of water. To effect this perfect combustion, the coal, powdered to pass through a sieve 1,000 meshes to the square inch, is intimately mixed with about 22 grams of $KClO_3$ and KNO_3, three parts to one. This mixture, in a small copper cylinder, is covered with a larger copper cylinder like a diving-bell, with a series of holes around its base. The mixture is ignited by a fuse, the copper furnace covered with the larger cylinder, and the whole is plunged under the water. The $KClO_3$ and KNO_3 furnish oxygen for the complete combustion of the coal, the gaseous products forcing their way in bubbles up through the water. In their ascent the bubbles are robbed of their heat by the water. Upon completion of the burning, the rise of temperature is determined by an accurate thermometer. A description of this method of Thompson is given in the Encyclopædia Britannica, under the head "Coal." The corrections upon the instrument have been determined by experience and theory, as follows:

1. Loss of heat from radiation, conduction, and correction. The calorimeter jar was filled with water about 6° F. above the temperature of the room, and its rate of cooling determined. The refinement of the experiment does not require either Newton's or Dulay & Petit's Law of Cooling. The following table gives the results:

Time.	*Ther. No. 1, in calorimeter.*	*Ther. No. 2, 1 inch from calorimeter.*	*Ther. No. 3, 1 foot from calorimeter.*
11:45 A.M.	79.2° F.	23.8° C.	23.2° C.
11:50 "	79.1	23.4	23.2
11:53 "	79.0	23.4	23.2
11:55 "	78.95	23.4	23.15
11:58 "	78.80	23.4	23.1
12:00 M.	78.70	23.4	23.1
1:00 P.M.	76.80	23.4	23.1
2:00 "	75.30	23.3	.....
1 h. 35 m.	Drop of 3.9° F.		

The loss is quite uniformly 0.03° F. in 1 minute. A burning requires about 3 minutes; hence the loss would be 0.1° F.

This loss is approximately compensated for by having the water in the calorimeter as much below the room-temperature before the burning as it is above at the close of the experiment.

2. Heat absorbed by metallic parts of the calorimeter. These parts weigh about 0.5 kilograms, with a specific heat of 0.095. Since there are approximately 2,000 grams of water, 2.4 per cent. must be allowed for absorption by the calorimeter.

3. Heat absorbed by the gases of combustion. This amount can be only approximated. The volume of the escaping gases is about 3,300 cubic centimeters. The rate of combustion is slow enough to allow these gases to issue into the air at about the temperature of the water, or about 5.4° F. above the room-temperature. Assum-

ing their specific heat to be on the average that of CO_2, for about 12° rise in temperature 0.9 per cent. must be lost.

4. The heat of the decomposition of the $KClO_3$ and KNO_3. This can be only approximately determined for the apparatus.

(*a.*) Two grams of pure carbon under combustion in the calorimeter gave 11,643 gram-degrees thermal effect. It is known that the perfect combustion of this amount of pure carbon should have produced 16,160 gram-degrees. The total loss is therefore 28 per cent. Of this, considering 3.3 per cent. as due to causes already mentioned in 2 and 3, 24.7 per cent. must be required for the decomposition of the oxygen-producing mixture.

(*b.*) In order to determine this amount in another way, if possible, the heat required for the decomposition of the 22 grams oxygen mixture was calculated in accordance with the methods and tables given by Pattison Muir.* This amount is as follows:

16.5 grams $KClO_3$ in decomposition gives out	1312	gram-degrees.
5.5 " KNO_3 " " " absorbs	6144	"
Amount absorbed for 22 grams, oxygen mixture	4832	"
" " by apparatus, by radiation, etc., (33 per cent)	533	"
Total amount absorbed	5365	"
2 grams pure carbon should give	16,160	"

The loss, therefore, (by calculation,) is 33 per cent., which does not differ greatly from that obtained by (*a*), or 28 per cent.

(*c.*) No attempt to estimate the heating powers from the chemical analysis of the coal is considered valuable. In this connection, M. L. Grunow, in the *Engineering and Mining Journal*, vol. XVIII, states: "It is evident that the manner of combination of the elements in coals is too variable to make it possible to determine their true heating power from simple elementary analysis."

5. By error in the amount of coal taken. All the coal was weighed in balances reading to 0.5 milligrams. A possible error of 1 milligram in the weighing would affect the result by only 0.05 of 1 per cent., a negligible quantity.

6. By error in amount of water taken. An error of 3 grams was a possible limit with the balances employed, and this would introduce an error of 0.15 of 1 per cent., a quantity also negligible.

From the above results it is evident that the correction of 10 per cent., recommended by the manufacturers of the apparatus, and hitherto adopted by experimenters, is far too small. The total correction is probably not far from *30* per cent.

In the following tables, corrections of both 10 and 30 per cent. are given, the former to render the results readily comparable with those of other experimenters with the same apparatus.

DESCRIPTION OF THE COAL BEDS, BEGINNING WITH THE LOWEST.†

A. The Leavenworth vein, at Lansing and Leavenworth: 24-inch vein, about 720 feet below surface.
B. The Cherokee, in Crawford and Cherokee counties, at Pittsburg, Weir City and vicinity: 42-inch vein; from outcropping to 70 feet deep.
C. Upper vein in Crawford county, now worked as strippings and slopes; 18-inch vein.
D. The Fort Scott coals: chiefly slopes and strippings; 28 inches — 14 inches.
E. The Linn county bed, at Pleasanton, La Cygne, &c.: 14-inch vein; 60 to 100 feet deep.
F. The Osage county veins, at Osage City, Carbondale, Burlingame and vicinity: Vein 18 to 20 inches; 35 to 85 feet deep.
G. Franklin county coal.
H. Cloud county coal.

*The Elements of Thermal Chemistry: Muir. 1885. Appendix I.

†See also "Composition of Kansas Coals," by Prof. E. H. S. Bailey, in this volume, p. 46.

Specimens were taken from localities as widely distributed as possible over the vein — north, south, east, and west — particularly north and south, as the veins dip west and north. The results may be considered as fair representatives of the whole vein, and also as embracing the principal veins at present worked in the State of Kansas. These results are presented in the following table. For comparison sake there is included also tests of the best Indiana block coal (Clay county).

TABLES.

[NOTE.—About *one-half* the evaporative powers here given in the first column will be obtained in steam boilers.]

[NOTE.—Best Indiana Block gives 14.43 and 17.04 pounds evaporative power for 10 and 30 per cent. corrections, respectively.]

A.—CHEROKEE COALS.

(Pittsburg, Weir City, Scammonville, Frontenac, Stillson, &c.)

Number of sample.	*Pounds water at 212° evaporated, per pound coal.* CORRECTION ON APPARATUS.		*Duration of burning, seconds.*	*Remarks.*
	10 per cent.	*30 per cent.*		
1	13.53	15.97	40	
2	13.64	16.10	45	
3	13.01	15.35	45	
4	13.31	15.71	60	
5	13.31	15.71	60	Violent burning.
6	13.86	16.36	65	
7	13.53	15.97	50	Violent burning.
8	13.94	16.45	75	
9	13.42	15.84	90	
Average	13.51	15.94		
All samples mixed	13.42	15.84	80	

B.—CHEROKEE, (upper vein.)

(Pittsburg.)

1	12.43	14.67	55	
2	12.76	15.06	45	
3	13.31	15.71	60	
Average	12.83	15.14		
All samples mixed	12.54	14.80	60	

C.—FORT SCOTT COALS.

1	13.64	16.10	65	
2	13.09	15.45	60	
3	13.86	16.35	55	
Average	13.53	15.97		
All samples mixed	13.20	15.58	120	

D.—LEAVENWORTH COALS.

1	13.36	15.76	75	
2	12.25	14.46	80	Brown residue.
3	13.86	16.35	65	
Average	12.95	15.52		
All samples mixed	12.54	14.80	105	

E.—LINN COUNTY COALS.

(Pleasanton, La Cygne, &c.)

1	12.76	15.06	60	
2	12.76	15.06	70	
3	12.87	15.49	80	Brown residue.
4	12.54	14.80	75	
Average	12.73	15.10		
All samples mixed	12.76	15.06	100	

F.—OSAGE COUNTY COALS.

(Osage City, Scranton, Carbondale, Burlingame, &c.)

Number of sample.	Pounds water at 212° evaporated, per pound coal. — CORRECTION ON APPARATUS.		Duration of burning, seconds.	Remarks.
	10 per cent.	30 per cent.		
1	11.88	14.02	110	Brown residue.
2	10.96	12.93	90	"
3	12.98	15.32	120	"
4	11.66	13.76	120	"
5	12.43	14.67	120	"
6	11.99	14.15	165	"
7	11.66	13.76	120	"
8	11.88	14.02	120	"
9	11.55	13.63	70	"
10	11.44	13.50	80	"
11	11.66	13.76	105	"
Average	11.76	13.96	.....	
All samples mixed	12.10	14.28	135	

G.—FRANKLIN COUNTY COAL.

1	12.32	14.54	125	.....

H.—CLOUD COUNTY COAL.

1	9.90	11.68	135	.....

SUMMARY.

From these results, the Kansas coals thus far examined are to be arranged in the following order as regards their evaporative powers.

[NOTE.—About *one-half* the evaporative powers here given under the 10 per cent. correction, will be obtained in practice.]

Order	Name of coal.	Table.	Pounds water evaporated per pound coal.		Duration of burning—seconds.	Calories gram-degrees Centigrade. — CORRECTION.	
			10 per cent.	30 per cent.		10 pr ct.	30 pr ct.
1	Cherokee	A.	13.42	15.84	65	7206	8506
1	Fort Scott	C.	13.20	15.58	60	7088	8364
3	Linn County	E.	12.76	15.06	65	6852	8105
4	Cherokee, upper vein, Leavenworth,	B. D.	12.54	14.80	50 75	6734	7946
5	Franklin County	G.	12.32	14.54	125	6615	7806
6	Osage County	F.	12.10	14.28	115	6498	7668
7	Cloud County	H.	9.90	11.68	135	5316	6273
	For comparison: Best Indiana Block (Clay county)	.....	14.43	17.03	.....	7749	9144

The coals depreciate in their steam-producing powers from the southeastern part of the State toward the north and west. Prof. Bailey finds they depreciate in the amounts of fixed carbon in a similar order.

PHYSICAL LABORATORY, STATE UNIVERSITY, Oct. 1888.

THE COMPOSITION OF KANSAS COALS.

BY E. H. S. BAILEY, PH.D.

The eastern part of the State of Kansas is fortunately underlaid with a fair quality of coal. With the increased population, the introduction of important manufacturing industries, and the extension of the several lines of railway, there is

naturally a greater demand for cheap fuel, and a greater interest in its economic supply.

The coal beds may be divided into several groups, the lowest being in the extreme southeastern part of the State. Above the thin local deposits in the vicinity of Baxter Springs, appears the Cherokee vein, the most important in the State. This crops out along a line about 30 miles in length, extending from Columbus to Mulberry on the Missouri line. There are important workings at Columbus, Scammonville, Weir City, Pittsburg, Frontenac, and Litchfield. The dip of the vein, which is about thirty-six inches in thickness, is towards the northwest. The coal is mined both by stripping and by the use of shafts to a depth of one hundred and twenty feet.

Above the Cherokee coal there is an outcrop of a thinner vein, which we have called the "Cherokee upper vein." This is worked to a limited extent in the vicinity of Pittsburg, though it is possible that the coal mined at Arcadia may belong to the the same vein. The seam is less than two feet in thickness.

As we ascend in the series, the Fort Scott coals next claim attention. These occur near the surface, and are mined in several places in the vicinity of Fort Scott. On the bluffs of the Marmaton river, east of the city, the coal is mined by stripping or in shallow slopes. There are banks in other localities, also. The vein is about twenty inches in thickness, and is known as "red coal," from the fact that it so readily oxidizes and becomes covered with iron-rust. The output of this excellent coal is small, and is mostly consumed in the vicinity.

The Leavenworth coal, from its similarity to the coals of Bourbon county, may be noticed in the connection. There are three shafts in actual operation, and two others are being sunk. The coal is mined at a depth of seven hundred and thirty feet, the vein being about twenty-two inches in thickness.

The Linn county coal is mined most extensively in the vicinity of Pleasanton and LaCygne. The coal is found at a depth of from sixty to one hundred and ten feet, and the vein is about twenty-two inches thick.

The Osage county coal-measures, from their accessibility and proximity to market, are very extensively worked. The outcrop of the field extends from near the Neosho rapids in a northeasterly direction into Shawnee county. Although stripped in a few places, it is usually mined by means of shafts from thirty to one hundred feet in depth. The vein, which has a slight dip to the northwest, is about seventeen inches in thickness. Some of the most important mining plants are located at Carbondale, Scranton, Burlingame, Peterton, Osage City, and Barclay.

Only one specimen of coal has been examined from Franklin county, and one from Minersville, Cloud county.

In obtaining the samples of the coals analyzed, all the mines, with the exception of the Ransomville and Cloud county, have been visited personally. Samples from all the different sizes of coals mined have been taken, in order to get the average of the coal as sent to the consumer.

The ordinary method in use among chemists for the analysis of coals has been followed. The actual amounts of carbon, hydrogen, etc., present in the coals, are not determined, but by the process we do determine the actual amounts of substances driven off under similar conditions, so the method is a valuable one for the comparison of coals.

In the analyses which follow, it will be noticed that the average for each region is given in the line below each variety. In the summary of averages, the analyses of some other coals are given for comparison.

COMPOSITION OF KANSAS COALS.

A.—CHEROKEE.

Number.	*Water.*	*Volatile.*	*Fixed carbon.*	*Ash.*	*Color of ash.*
1	1.54	38.06	53.44	6.96	Gray.
2	1.26	35.60	52.20	10.94	Drab.
3	1.37	37.19	50.23	11.21	Reddish gray.
4	2.59	39.12	51.54	6.75	Brownish.
5	1.35	36.11	50.94	11.60	Gray.
6	2.49	34.59	54.11	8.81	Light gray.
7	2.76	36.21	54.91	6.12	Light gray.
8	2.75	36.76	53.08	7.41	Gray.
9	1.33	37.33	51.59	9.75	Brownish gray.
Average	1.94	36.77	52.45	8.84	

B.—CHEROKEE, (UPPER VEIN.)

1	2.23	34.17	49.51	14.07	Grayish brown.
2	2.07	34.37	50.21	13.35	Grayish brown.
3	1.91	37.44	46.19	14.46	Gray.
Average	2.08	35.32	48.64	13.96	

C.—FORT SCOTT.

1	2.35	42.79	45.00	9.86	Reddish.
2	2.21	43.89	45.15	8.75	Reddish brown.
3	4.27	38.61	52.49	4.63	Reddish brown.
Average	2.94	41.76	47.55	7.75	

D.—LEAVENWORTH COUNTY.

1	3.22	41.55	49.32	5.91	Dark red.
2	2.25	36.49	47.27	13.99	Light red.
3	2.61	39.58	45.65	12.16	Brick color.
Average	2.69	39.21	47.41	10.69	

E.—LINN COUNTY.

1	1.61	38.25	48.76	11.38	Dark brown.
2	2.36	40.14	48.88	8.62	Reddish brown.
3	2.39	42.19	42.05	13.37	Yellowish brown.
4	1.92	37.11	47.87	13.10	Red.
Average	2.07	39.42	46.89	11.62	

F.—OSAGE COUNTY.

1	7.19	40.03	41.13	11.65	Brown.
2	7.71	41.56	39.92	10.81	Light brown.
3	9.29	42.05	40.89	7.77	Red.
4	4.70	44.86	42.11	8.33	Dark brown.
5	6.75	42.79	40.97	9.49	Dark brown.
6	7.27	41.45	41.35	9.93	Dark red.
7	5.56	42.79	39.32	12.33	Dark red.
8	5.83	43.26	41.75	9.16	Reddish brown.
9	7.36	38.33	38.54	15.77	Dark brown.
10	4.91	39.58	43.17	12.34	Yellowish brown.
11	7.77	40.85	40.29	11.09	Light brown.
Average	6.76	41.59	40.86	10.79	

G.—FRANKLIN COUNTY.

1	7.55	44.40	37.68	10.37	Gray.

H.—CLOUD COUNTY.

1	13.70	46.14	28.52	11.64	Dark gray.

The *averages* as given above are collected in the following table:

Name.	*Water.*	*Volatile.*	*Fixed carbon.*	*Ash.*
Cherokee	1.94	36.77	52.45	8.84
Cherokee, (upper vein)	2.08	35.32	48.64	13.96
Fort Scott	2.94	41.76	47.55	7.75
Leavenworth county	2.69	39.21	47.41	10.69
Linn county	2.07	39.42	46.89	11.62
Osage county	6.76	41.59	40.86	10.79
Franklin county	7.55	44.40	37.68	10.37
Cloud county	13.70	46.14	28.52	11.64
Pittsburgh, Pa.	1.31	36.61	54.17	7.91
Nebraska	4.93	38.17	49.44	7.46
Warren county, Missouri	6.75	36.40	45.75	11.10

If the water and ash are eliminated in the calculation from the above results, as is suggested in a recent report of the Pennsylvania Geological Survey, the coals of Kansas will be divided into five groups. In the first group are included the Cherokee coals; in the second, Fort Scott, Leavenworth and Linn counties; in the third, Osage county; in the fourth, Franklin county; and in the fifth, Cloud county.

The coals found in the extreme southeast are richer in fixed carbon or coke, and this diminishes as we go toward the northwest. On the other hand, the volatile matter is more abundant compared with the fixed carbon in the upper or northern coals. There is uniformly more water in the Osage county coals and in those above it, than in the lower coals. In regard to ash, Cherokee and Fort Scott contain the least; the others contain from 10 to 12 per cent.

As the sulphur is so unevenly distributed, an analysis for this was not made. Previous examinations, however, show that there exists from 2 to 5 per cent. of sulphur. A part of this may be present in sulphate of lime, but much of it is united with iron in iron pyrites.

This examination was taken up for the purpose of preparing a report for the State Board of Agriculture. The specimens reported above are identical with those discussed by Prof. L. I. Blake, in the article on "The Evaporative Power of Kansas Coals," which appears at page 42 of this volume.

In conclusion, I wish to acknowledge the very valuable assistance afforded me by Mr. L. T. Smith, in the performance of a large part of the analytical work required in this investigation.

ON THE ECONOMIC VALUE OF CORN-COBS.

BY E. H. S. BAILEY, PH. D.

[*Abstract.*]

The importance of utilizing all possible varieties of fuel is most apparent in those parts of the country where fuel is scarce, so that the project to make use of any waste material in a prairie region is in the direction of greater economy.

Cobs bring a fair price as fuel in many towns in Kansas, but the chief difficulty with their use is that they are so rapidly consumed. Some time ago, in connection with E. L. Nichols, I made a few experiments on the possibility of obtaining gas from the cobs, and by this means getting the fuel in a concentrated form. By heating the ground cobs in a small iron retort, it was found that gas was readily made. This gas was not rich in those hydrocarbons which produce light, but contained more carbon monoxide (CO) and hydrogen. By passing this gas through gasoline or some

similar light hydrocarbon, it could readily be changed into illuminating gas. When this gas burns, no sulphur compounds are given off, and the products of the combustion would be only carbon dioxide (CO_2) and water. This process would only be of value where cobs were very cheap and abundant. If it were possible to heat the retort by means of the cob charcoal, or some other waste material, this would diminish the expense.

By burning the cobs in an open stove, it was found that they would yield a little over one per cent. of ash. This ash on analysis contained the following substances:

	Per cent.		*Per cent.*
Silica and insoluble residue	38.13	Sulphuric anhydride	1.40
Alumina	2.02	Chlorine	.57
Ferric oxide	3.91	Sodic carbonate	2.59
Phosphoric anhydride	5.27	Potassic carbonate	38.65
Calcic oxide	1.71	Moisture and carbon	traces.
Magnesic oxide	2.18		

The valuable materials in this ash are the phosphoric anhydride and the potassic carbonate. One thousand pounds of cobs would therefore yield ten pounds of ash, which would contain about one-half a pound of phosphoric anhydride, and three and eight-tenths pounds of potash. Ordinary wood contains from four-tenths to three and nine-tenths pounds of potash per one thousand pounds. Corn-stalks are very rich, containing seventeen and one-half pounds per thousand.

IS THE ALKALOIDAL STRENGTH OF TEA AN INDEX OF ITS COMMERCIAL VALUE?

BY PROF. L. E. SAYRE,
Department of Pharmacy, Kansas State University.

It will be seen from the title of this paper that the following chemical assay of some of the tea of the market was made with a view of ascertaining, if possible, the relation between alkaloidal strength and commercial value.

The popular belief is that the higher-priced teas are stronger in *theine* (alkaloid) than the cheaper grades. The following figures will serve to show the truth or fallacy of this belief.

For examination, eleven samples were selected, representative of some of the different brands upon the market. They were as follows:

1. Formoso Oolong	90 cents per lb.	7. Imperial	65 cents per lb
2. Formoso Oolong	60 " " "	8. Gunpowder	70 " " "
3. Japan	70 " " "	9. Gunpowder	50 " " "
4. Japan	25 " " "	10. Tea dust, green	20 " " "
5. Young Hyson	70 " " "	11. Tea dust, dark	20 " " "
6. Young Hyson	40 " " "		

Ten grams of the powdered leaf were mixed intimately with two grams of calcined magnesia; the mixture, coarsely powdered, was treated with 100 cc. of boiling distilled water. The boiling was continued five minutes. The whole was transferred to a percolator, and the residue percolated with 50 cc. of boiling distilled water. The dregs were then returned to the beaker and boiled again with 100 cc. of water; transferred to a percolator, and then percolated until exhausted. The percolate was then evaporated on a water-bath to about 20 cc., and transferred to a separator. The alkaloid (theine) was then washed from this concentrated percolate by means of chloroform, using three or four portions of 25 cc., each successively, (the last washing leaving upon evaporation no residue.) The washings were then mixed and

evaporated, and the residue, consisting of nearly pure theine, was dried and weighed. The results obtained were as follows:

No. 1,	at 90	cents	per	pound	.....	2.73	per	cent.	theine
" 2,	" 60	"	"	"	.....	3.67	"	"	"
" 3,	" 70	"	"	"	.....	3.10	"	"	"
" 4,	" 25	"	"	"	.....	2.14	"	"	"
" 5,	" 70	"	"	"	.....	2.69	"	"	"
" 6,	" 40	"	"	"	.....	2.49	"	"	"
" 7,	" 65	"	"	"	.....	2.58	"	"	"
" 8,	" 70	"	"	"	.....	3.05	"	"	"
" 9,	" 50	"	"	"	.....	2.12	"	"	"
"10,	" 20	"	"	"	.....	2.09	"	"	"
"11,	" 20	"	"	"	.....	2.21	"	"	"

It would apear from the foregoing that there is no fixed relation between the commercial value of tea and its alkaloidal strength. A tea, for example, at 20 cents per pound, has more alkaloid present than one at 50 cents per pound; and one at 90 cents per pound has less of theine represented than one selling at 60 cents per pound. From a *medical* point of view, this determination is of practical value, for, contrary to the general belief, physiologically considered, a tea (being valuable only in the proportion of alkaloid present) is valuable or not regardless of commercial consideration.

THE QUALITY OF COMMERCIAL PEPPERS.

BY PROF. L. E. SAYRE,
Department of Pharmacy, Kansas State University.

There seems to be a wide difference of opinion as to the extent of adulteration of ground spices. Some hold that it is a difficult matter to obtain a pure spice in common use as condiment, and others, equally good authorities, hold that, when ordinary care is used in purchasing, it will be found that adulteration is the exception rather than the rule.

To determine which of these two views is the correct one, will require much more time than I have been able to give to the subject; but I have made examination of a number of samples of the most familiar and largely used of all condiments—black pepper—with a view of contributing something in this direction. Accordingly, ten samples were obtained in open market, care being taken to not duplicate brands, and to get a fair average of pepper from different sources sold in the retail stores. These were all subjected to the same process of analysis.

Before stating the result, it may be well to say that in the examination special stress was laid upon the amount and character of the fixed residue, remaining after the evaporation of an ethereal percolate.

It is well known that an ethereal percolate of ground pepper contains in solution, almost wholly, *volatile oil*, *resin*, and the alkaloid *piperine*.

It may also be known that the evaporated residue (the fixed residue) contains resin and piperine, the volatile oil having escaped during evaporation.

The determination of ash and moisture is desirable, but not to be depended upon as a method of estimating value. An excess of ash would indicate, possibly, sand or earthy matter, but starch could not be detected by incineration. As to the determination of moisture, no reliance need be placed upon the determination of this constituent, for pure pepper may vary greatly in this respect, containing from 12 to 9 per cent. of water.

As stated previously, I have laid more stress upon the evaporated ethereal extract, believing this data to be a surer index of power, taken by itself, than any other. I

have made, however, all three of the above determinations: namely, moisture, oleoresin (evaporated ethereal extract), and ash. In some cases these three data, taken together, are necessary in determining values.

According to Mr. Bell, *American Journal of Pharmacy*, Oct. 1888, the appearance of the evaporated ethereal extract must be carefully noted, as it affords an excellent clue to possible adulteration. It should be dry, somewhat scaly, and the resin should show numerous projecting crystals of piperine. If it has a dark, oily appearance and is mostly amorphous, adulteration is indicated.

I may add that it is not only a *dark* coloration of the residue that indicates adulteration, but if the color is of a very *reddish* hue in thin layers, the indication is, presence of capsicum, (added, doubtless, to give pungency to the inert adulterant.)

The result of the examination is as follows:

	Moisture.	*Resin and piperine.*	*Ash.*
No. 1	10.43	4.6	5.5
No. 2	10.34	10.3	2.5
No. 3	14.25	7.3	2.
No. 4	9.75	7.9	5.
No. 5	Lost.	5.1	1.5
No. 6	11.20	7.8	7.
No. 7	7.10	7.2	2.5
No. 8	11.25	4.9	2.5
No. 9	10.78	6.6	3.
No. 10	9.80	5.9	3.

In conclusion, I would say that a physical examination is quite essential to a satisfactory analysis of pepper. This I have not as yet made, because I have yet to select the adulterated specimens of other samples, and then, by microscopic examination, determine the kind of adulterants used. This can be done very largely by physical examination.

ANIMAL ETHICS.

BY A. H. THOMPSON, TOPEKA, KANSAS.

The following brief contribution to the study of animal ethics, comparative ethics, or morals among animals, is submitted without comment upon the more elaborate studies of the subject that may have been made by the masters in natural science, but is presented merely as amateur browsings in a very interesting field of psychological research.

At the outset we are met by the query: Do animals possess a morality at all? Do they ever distinguish between right and wrong, between justice and injustice, kindness and cruelty, honesty and dishonesty, vice and virtue, and other moral attributes, among and between themselves? Do they have any respect for the rights of others? Do they ever attempt to control their own selfish impulses for the good of others, or for the good of an animal community? Let us make a study of their moral manifestations, and endeavor to obtain an answer to these queries.

A great difficulty confronts us at the beginning of our investigations by the apparently complete absence of similarity or sympathy between the mental processes and reasoning actions of the lower animals and of man. Not only is the nervous organization of man of a much higher grade, and his mental powers consequently much superior, but the methods of his mind are of a very different order. Both in quantity and quality of psychic processes he varies infinitely from the other animals around him, so that he has little in common with them. But yet his mind, with his nervous organization and his physical body, must have ascended through ages of animal ancestry to its present supreme position. The process of evolution has pro-

duced a being totally different from, and vastly superior to, all the forms through which he has passed in development. While retaining much that betokens the animal in mental constitution, and as regards mere nervous actions, yet the superimposed qualities — the soul if you please — mark him, and set him apart as a distinct being — an animal with the touch of divinity.

But yet in the earliest history of his species his mental powers and emotions were but little different, either in quantity or quality, from the other animals around him, and he waged a warfare for mere existence on the same level with them. But from this he passed on to a higher plane, and became a different order of being. It is not possible for us to carry ourselves back in imagination over the path of our wonderful mental development to the time in the infancy of our species when the mind of man was wholly undifferentiated from that of other mammals. Yet that would be necessary to place ourselves *en rapport* with the animal mind, for at that stage man thought and acted like the animal that he was. We are, therefore, forced to make our study *objective*, rather than *subjective*, and to investigate the animal mind through its phenomena. This places us at a disadvantage at once. But not so much as would appear at first thought, when we consider that science is but the study of phenomena and their classification; and from the constancy of phenomena, theories, principles and laws are elaborated. From this, the scientific standpoint, we will endeavor to make a brief study of animal ethics, which will be suggestive rather than exhaustive.

In the first place we notice that the animal mind, and through the mind, the emotions and impulses, is controlled and moulded by two great dominating instincts: the first is the instinct of self-preservation; the second is that of the propagation of the species. Around these absolute and all-powerful faculties cluster all the minor mental and emotional actions and manifestations that we are pleased to call the indications of reason or affection.

The first, the instinct of self-preservation, is essentially and purely selfish. It is prompted by the instinctive and perhaps somewhat reasoned desire to live and avoid suffering, and escape death. The desire for life is inherited and unconscious. The fear of pain is instinctive; but, in addition, as the animal lives, this is accelerated by experience and observation. The fear of death — the understanding of death, as observed in other animals dying or dead, must be an inherited instinct, mounting to the plane of conscious reasoning, for an object in fighting is to produce death, which, they must reason, renders an adversary harmless, or an edible animal fit for food. So, too, it must become, in their minds, a condition which they fear and dread, much, indeed, as man does, and with much the same indefinite understanding of it. If they could grasp the idea of immortality, self-preservation would prompt them to yearn for such a condition also, as man does.

One of the worst features of this strong instinct is, that in the procuring of food, in warfare, defensive and offensive, etc., it is the cause of much destruction of life, and too often develops into wantonness, merely for the love of killing. Unavoidable cruelty is bad enough, from our moral standpoint — barely allowable, in fact, seeing that we practice it. But there is a difference in the fact that we do, or should, regret the necessity of destroying life that we may live; but animals do not seem to possess any such feeling; on the contrary, throughout the whole carnivorous kingdom, at least, the great prey upon the less, the strong upon the weak, the weak upon the still weaker, and so on down to microscopical infinity. Nature is one vast slaughter-house — cruelty, death, destruction are everywhere. This destruction is often causeless, and is always selfish and heartless. It is devoid even of the chivalrous element of combat, of challenge, and equal chance, for it is usually a cowardly assault of the strong upon the weak. However, man can claim little moral superiority in that respect, for in the commercial world the strong continually prey upon the weak,

and often without the excuse of the necessity for self-preservation, but merely for the greed of gain. There is no excuse for it in either case, except the cruel and heartless law that might makes right.

But for the practice of the cruelty prompted by the instinct of self-preservation, there is an amount of reasoning power exhibited by animals by the expedients employed in emergencies, that we cannot but admire while we deplore the motive. This is strikingly illustrated by those incidents so familiar to all students of natural history, wherein a considerable amount of reasoning is employed, of judging from cause to effect, of complicated strategy, etc., for the purpose of obtaining food, either by deceiving and entrapping other animals, or to secure inaccessible vegetable food. Such incidents display a knowledge of the habits of other animals, or of the qualities of natural products, which could come only from intelligent observation — the same methods of reasoning, perhaps, that are employed by man in attaining the same knowledge. These powers are employed also, of course, in self-protection, and in attempts to escape from pursuit, and often with the greatest success.

But here we are glad to record that this intelligence is not always exercised for self alone, but often in an unselfish way for the benefit of other individuals. Strong animals thus often assist the weaker ones; those which appeal to heart-like sympathy by their helplessness, either through sickness or injury. They will protect such unfortunates from the attacks of others, take them to shelter, carry them food if unable to be led to it, and perform other unselfish acts, which are prompted purely by love and friendship. Not only is this of common occurrence with dogs and other animals of higher intelligence, but of many lower vertebrates, and even of the invertebrates. Snails have been known to display this affection and care of the stronger for the weaker. Indeed, the strong often suffer by the willing sacrifice of food to the weak, and go hungry. And beyond that they will sometimes give their lives for that of a companion, or for man. Surely human devotion and love can go no further than that. Such manifestations of affection and friendship are pleasant to record, as they stand out in such vivid contrast against the background of universal animal cruelty. In this connection we also note the expressed sympathy and affection displayed for companions in suffering and distress. Ants have been observed to exhibit this feeling; and it is common among the higher vertebrates.

Then, again, we must note with pain too frequent inexplicable cruelty exhibited by the ruthless destruction of wounded or disabled companions. Even the domestic animals sometimes practice this. We cannot understand if this is because they wish to put the sufferer out of misery, or the fear that the cries or blood may attract fierce carnivora; but it must be an inherited impulse.

A marked instance of ethical feeling, of regard for the rights of others, is exhibited in animals which associate in numbers for mutual advantage to capture prey and then mutually grant a division of the food so obtained. This displays thoughtfulness for each other, and honesty as regards partnerships. It also indicates some intelligence in appreciating the value of association and coöperation, and is one of the many instances which necessitates some mode of communication by which there is mutual understanding. There is a sense of duty and of obligation which compels a fair division and recognizes equal rights. We must give such animals credit for not indulging in cannibalism, even when excessively hungry, although they do commit a cruel crime in destroying wounded companions. In this association we must give them credit for mutual confidence and fidelity, and perhaps of affection — for who can tell what friendships may exist even among the most savage animals? Then bees and ants rise to higher level in their complicated communities, in which there is such a division of labor and mutual understanding as to closely resemble human community life.

In this connection, we may note one of the most remarkable results of the workings of self-preservation — the slavery of other animals. The most remarkable instance of this, of course, is the slavery among ants. But with them the servitude is compensated for by the protection afforded, and the plentiful food supplied to the slaves, and is therefore not all unkindness. Some warlike species cannot live at all without their attendant slaves to wait upon and feed them. It is to be questioned if the enslaved are worse off than when in freedom, for the consideration of sentiment does not reach them at all. Ants also enslave the aphides for the sweet secretion, the milk, which they yield. This, however, is akin to domestication, and is comparable to our domestication of other animals. Compulsory servitude is slavery when applied to our species — domestication when applied to other species of animals. But the masters make a complete return for services rendered, in supplying all the wants of the enslaved species.

But again, there is a kind of servitude that is without any redeeming merits whatever, and is indeed cruel and heartless. This is illustrated by certain birds, as the frigate bird, which obliges the fish hawk to fish for him, and the sea gull, which exacts such service from the cormorant. Not only do they rob the unfortunates of the fruits of their industry, but purposely compel them to catch more for their tormentors. This is a compulsory servitude, a rank robbery of work, without the return of food, or protection, or any other compensation. This slavery has now gone on so long that the dominant species cannot live without it, and in the case of the frigate bird the feet and claws are now so reduced by disuse that it cannot catch its own fish if it desired to do so. Some species of fish hawks, during generations of this slavery and subjugation, have become hereditarily accustomed to it, and obey the tyrants of the air without much objection. Other species, not so well accustomed to it, are often driven to the death by these cruel despots, through misunderstanding of what is wanted of them. Instances of unrequited service are found in other species of animals, as well as in man.

The affectionate personal attachment that animals often manifest for each other, or between members of different species, as a dog and horse, cat and horse, dog and elephant, etc., is proof of their possession of the higher feelings and emotions. The fidelity of the dog is so pure and unselfish as to put to shame our own species, with all our boasted moral exaltation, and needs only to be mentioned in this connection. There are many curious friendships throughout the animal world, such as the plover and the crocodile, the rhinoceros-bird and his host, and similar attachments. Birds seem to possess the most love and friendship, and their fidelity and love for each other are proverbial. Snails have also been known to display an affection for a particular person. But this feeling is manifested in all species, and especially in the higher mammals, whose attachments for each other or for man are so well known, and which sinks all selfishness in its regard for others.

The sexual and parental instinct is the second greatest animal impulse, on which depends the perpetuation of the species, and is the center of a variety of emotions and mental actions. The instinct of self-preservation often disappears before the assertion of the instinct of perpetuation of the species. Many a battle-scarred old male bears testimony to the devotion and self-sacrifice of his sex in the cause of gallantry toward the gentler sex. Much cruelty is consequent upon the conflict of males for supremacy in the favor of the females, and they willingly endure much pain and suffering. Of course, the sexual passion is the inspiring force, but this is sometimes elevated by a strong personal attachment and true friendship, which often lead to life-long companionship. With the females, of course, the maternal instinct is the all-powerful controlling power, and develops a beautiful, self-sacrificing devotion to offspring in almost all species. This feeling is a pure love, as devoted and

self-forgetful as in the human species. The mothers, in almost all animals, especially mammals and birds, willingly, and often needlessly, run risks, and sacrifice their lives to save offspring from real or fancied danger. With insects, there is little of this feeling, for the mother perishes with the laying of the eggs as a rule, although great care and affection are bestowed upon the preparation of the nest, and depositing the eggs. It is the one object and passion of their lives. Fish often exhibit a strong feeling for the eggs as the young; but reptiles do not give much attention to the young, and rarely display any affection for them. But the idea of duty, in caring for the young, is probably never conceived by animals, and instinct takes its place to insure perpetuation of species.

The idea of property rights is often exhibited by animals, especially in the protective instinct of the dog. It must be manifested to some extent in wild animals in regard to the ownership of game or food, as in respecting the rights of domicile; but of this we have no direct proof. There are examples, however, of the rights of parents in their offspring being regarded by stronger animals.

But we must close our study of the subject for the present, with the hope of contributing other suggestions in the future, and especially with the wish that these random thoughts may provoke observation and discussion in others.

MAMMALS OF WESTERN KANSAS.

BY A. B. BAKER, OF WAKEENEY, KANSAS.

The following is a list, accompanied by a few brief notes, of mammals found along the hundredth meridian between N. latitude 38.30 and 39.30.

This list, having been prepared without access to authorities, will unavoidably contain inaccuracies in nomenclature and otherwise.

Only such species are included as have been taken by the writer within the past five years.

FELIDÆ.

Lynx rufus, Raf., (Wild Cat): Common along wooded streams, and among the chalk bluffs; preys but little upon sheep or poultry. Two females taken in May; contained two young each.

MUSTELIDÆ.

Putorius longicauda, Rich., (Long-tailed Weasel): Not common; inhabits prairie dogs' burrows and holes among rocks; not seen here till the present year.

Putorius nigripes, Aud. & Bach., (Black-footed Ferret): Lives in prairie dogs' burrows, and preys upon these rodents; makes occasional inroads also upon poultry. It is generally to be found in the larger prairie-dog "towns," but is nowhere numerous.

Lutra canadensis, Sab., (Otter): Occasional along streams.

MELINIDÆ.

Taxidea americana, Waterh., (Badger): Common; lives in burrows on the open prairie.

Mephitis mephitica, Shaw, (Common Skunk): Very numerous and destructive to poultry.

Spilogale interrupta, (Little Striped Skunk): Not seen here till the autumn of 1887. Of twenty skunks taken since that time, one-third were of this species.

CANIDÆ.

Canis occidentalis, (Gray Wolf): Formerly quite numerous; now uncommon, and found only in rough country along streams.

Canis latrans, Say, (Coyote): Very numerous, and destructive to sheep and poultry.

Canis familiaris latrans: A spotted hybrid between the coyote and common dog, shot among a pack of coyotes.

Vulpes velox, Say, (Swift Fox): Very numerous until within the past five or six years; now rarely seen. It lives in shallow burrows on the open prairie.

PROCYONIDÆ.

Procyon lotor, Storr., (Raccoon): Common in bluffs and rough banks along streams.

ANTILOCAPRIDÆ.

Antilocapra americana, Ord.,(Antelope; Pronghorn): Still comparatively common; and, until quite recently, very numerous.

CERVIDÆ.

Cervus macrotis, Say, (Black-tailed Deer): Quite common till within the past few years; now found only occasionally, and in the roughest country.

VESPERTILIONIDÆ.

Lasiurus noveboracensis, Tomes, (Red Bat): Common; found in corn and sorghum fields.

Scotophilus noctivagans, LeConte, (Silvery-haired bat): Only one individual taken; captured indoors; attracted probably by the light.

Vespertilio ciliolabrum, Merriam: Found in clefts of the rocks, and in swallows' nests. The first individuals captured of this species were taken here in August, 1884, when scores of them were seen. None have been seen here since that time. The following year, two individuals of this species were taken in southwestern New Mexico.

SORICIDÆ.

Blarina exilipes, Baird, (Short-footed Shrew): Found on low ground, and occasionally on upland; not common.

TALPIDÆ.

Scalops argentatus, Aud. & Bach., (Silvery Mole): Found in low, moist ground; not common.

SCIURIDÆ.

Spermophilus tridecem-linealus, Aud. & Bach., (Striped Ground-Squirrel): Found everywhere; does great injury to corn and other crops.

Cynomys ludovicianus, Ord., (Prairie Dog): Exceedingly numerous; one "dog town" being more than sixty miles in length. They cause considerable damage by cutting down corn or other crops which obstruct their field of vision.

CASTORIDÆ.

Castor fiber, Kuhl., (Beaver): Formerly common, and found along all streams whose banks were not too sandy; it is now rapidly disappearing.

GEOMYIDÆ.

Geomys bursarius, Rich, (Pocket Gopher): Common.

SACCOMYIDÆ.

Dipodomys phillipsi ordi, Woodh., (Kangaroo Rat): Very numerous, especially in sandy bottom land, where it does much damage to corn and other crops; lives in separate holes; not in colonies, as farther southwest.

Perognathus fasciatus, Maxim.: Not common; found in sandy banks.

ZAPODIDÆ.

Zapus hudsonius, Coues, (Jumping Mouse): Rare; one individual was taken among willow brush on the bank of a stream.

MURIDÆ.

Mus musculus, Linn., (House Mouse): Found about buildings, and in cultivated fields. (Introduced.)

Neotoma floridana, Say & Ord., (Wood Rat; Pack Rat): Common; lives in holes among rocks, and in willow brush along streams.

Hesperomys leucopus sonoriensis, LeC., (White-footed Mouse): Very numerous in fields, and about houses and barns.

Hesperomys leucogaster, Maxim., (Mole Mouse(: Common in fields, and often found about farm buildings.

Ochetodon humilis, Aud. & Bach., (Little Harvest Mouse): Common in fields, and occasionally found about buildings; seen in the fields most frequently when the ground is covered with snow.

Arvicola austerus, LeC., (Prairie Meadow Mouse): Common; found in moist bottom lands and cultivated fields.

Fiber zibethicus, Cuv., (Musk Rat): Numerous along streams; solitary individuals, which were perhaps migrating, have occasionally been found at a considerable distance from water.

HYSTRICIDÆ.

Erethizon dorsatus epixanthus, Brandt, (Yellow-haired Porcupine): Found among bluffs, and where there is timber; not common.

LEPORIDÆ.

Lepus campestris, Bach., (White-tailed Jack Rabbit): Numerous; lives in burrows on the open prairie.

Lepus sylvaticus, Bach., (Cotton-tail Rabbit): Very common among bluffs, in brush along streams, and about cultivated fields.

Lepus callotis texianus, Waterh., (Black-tailed Jack Rabbit): Lives in burrows on the open prairie; very common.

THE ANHINGA.

(*Anhinga anhinga* Linn.)

BY N. S. GOSS.

Habitat, tropical and subtropical America, north to South Carolina, southern Kansas, and western Mexico.

This species was captured within the State, in the Solomon valley, in August, 1881, by Mr. C. W. Smith, of Stockton; and May 1st, 1888, Mr. Daniel Lambert, of Wilburn, Ford county, shot in the northern part of Meade county, on Crooked Creek, five of these birds, out of a small flock that arrived a few days before, and together. There is quite a thick grove of trees along the creek in this vicinity, and (it may have been disturbed) it is possible they might have nested there, and it may have been their occasional breeding-ground before the settlement of the county. The first time I met with the birds was at the mouth of the San Jacinto river, and on Buffalo bayou, Texas, during the last of March and first of April. I was too early for their eggs, but before I left they had commenced building their nests in the trees. The birds are more or less gregarious, roosting in small flocks at night in the tree-tops, and during the day, when at rest, are to be seen perched upon an old stub, or the lower branches of trees over the water. I found them very shy, and ever upon the alert, darting from their perch at the sight of an intruder, and disappearing beneath the water without scarcely leaving a ripple upon its surface, coming up hundreds of

yards away, and if badly frightened, only thrusting its bill out far enough to take in a supply of air; if the water is not perfectly smooth, it is useless to look for them. Its food is chiefly fish, which it catches beneath the water, where it flies, with the aid of its feet, as swiftly as in the air, rarely even at such times coming above the surface with more than the head and neck, which is so long, slim, and wavy in motion that it is oftener taken for a snake than a bird. When not fishing or apprehensive of danger, they ride up lightly on the water. I have since met with the birds all along the Gulf coast, and on the lagoons, and up the rivers that I visited in Central America.

The nests of the birds are placed on bushes, or branches of trees overhanging the water, varying in height from four to thirty feet. They are quite bulky, and made of sticks, and lined with leaves, rootlets, moss, etc.

Eggs, two to four; 2.12x1.34; pale bluish green, with more or less of a white calcareous covering; in form, oblong oval to ovate. A set of two eggs, taken April 28th, 1882, at the mouth of the Guadaloupe river, Texas, from a nest made of sticks and green twigs in leaf, in a willow tree, eleven feet from the ground, are in dimensions 2.20x1.66, 2.10x1.34.

THE DOUBLE-CRESTED CORMORANT.

(*Phalacrocorax dilophus* Sw. and Rich.)

BY N. S. GOSS.

In Kansas, migratory; not uncommon. Arrive the last of March to first of April. To be looked for in the old, deep channels of the rivers, in the low-timbered lands. Return in October.

Habitat, northeastern North America, south in winter to the Gulf coast; breeding from the Bay of Fundy northward and westward to Manitoba.

The birds are abundant on the northeast coast, decreasing in numbers westward to the Rocky Mountains. They have been reported west of the Rockies, and breeding there, but the specimens taken on the Pacific side prove to be an intermediate race between this species and *albociliatus*. The birds subsist chiefly upon fish, which they capture by diving and pursuing beneath the water with a speed that the swiftest of the finny tribe seldom escape, coming to the surface with their capture, tossing the same in the air and catching it head first as it falls, so that the fins will not prevent its passage into the stomach. The throat readily expands, and enables them to swallow fishes larger than the neck in its normal condition. I have often noticed the birds, when resting upon a log or perched upon a limb over the water, suddenly drop and disappear beneath its surface at the sight of a fish—catching it, however, in a fair chase, and not, like the gannet or kingfisher, by plunging upon their prey. All the birds of this family are voracious eaters, and the craving for food makes them active hunters, and they are successfully used in many places by fishermen, who tie a string around their necks to prevent their swallowing the catch. The Chinese, especially, rear and train the birds upon their boats for fishers, with great success.

LeConte says: "To this end, they are educated as men rear up spaniels or hawks, and one man can easily manage an hundred. The fisher carries them out into the lake, perched on the gunwale of his boat, where they continue tranquil, and expecting his orders with patience. When arrived at the proper place, at the first signal given, each flies a different way to fulfill the task assigned it. It is very pleasant on this occasion, to behold with what sagacity they portion out the lake or canal where they are upon duty. They hunt about, they plunge, they rise an hundred

times to the surface, until they have at last found their prey. They then seize it with their beak by the middle, and carry it without fail to their master. When the fish is too large, they then give each other mutual assistance: one seizes it by the head, the other by the tail, and in this manner carry it to the boat together. There the boatman stretches out one of his long oars, on which they perch, and being delivered of their burden, they fly off to pursue their sport. When they are wearied, he lets them rest for a while; but they are never fed till their work is over. In this manner they supply a very plentiful table; but still their natural gluttony cannot be reclaimed even by education. They have always, while they fish, the same string fastened round their throats, to prevent them from devouring their prey, as otherwise they would at once satiate themselves, and discontinue the pursuit the moment they had filled their bellies."

The birds breed in communities, and where the ground or rocks will admit, their nests are placed closely together. On the last of July, 1880, I found the birds breeding in the Gulf of St. Lawrence, on the sides of the cliffs on Bonaventure Isle, and on the top of Perce Rock. The latter cannot be climbed, and nearly all the nests upon the isle were beyond reach; those examined, however, had young birds from half to nearly full grown, and hundreds of little fellows could be seen either upon their nests or standing near by upon the rock. The birds are very filthy, and the stench about their breeding-grounds sickening. Their nests are made of sticks, moss from the rocks, and sea-weed. Eggs, three or four—2.50x1.56; pale bluish-green, coated with a white chalky substance, but more or less stained in their dirty nests; in form, elongate ovate.

ADDITIONS TO THE CATALOGUE OF THE BIRDS OF KANSAS—WITH NOTES IN REGARD TO THEIR HABITS, ETC.

BY N. S. GOSS.

THE WESTERN GREBE.

(*Æchmophorus occidentalis* Lawr.)

Habitat, western North America, eastward to Manitoba; accidental in Kansas.

For this addition to our list, we are indebted to Prof. F. H. Snow, who reports that a young male was killed November 3, 1887, on the Kansas river, at Lawrence. The birds are quite common on the northwestern part of the continent; breeding in reeds, ponds and lakes, east to northern Dakota and Manitoba; wintering along the Pacific coast south into Lower California; but this capture east of the Rocky Mountains is the first mention that I can find of their appearance south of their breeding-grounds. I have noticed this large species at San Diego several times; and in the winter and early spring of 1882 I had a good opportunity to observe them on the waters of Puget Sound. The birds ride the water lightly, and their silky plumage, slender build, long, waving necks and graceful carriage can but attract the attention of the most indifferent of observers. It ranks high among the water birds, and is, by right, the queen of the family. Like all of the race, they are expert swimmers and divers, and can quietly sink out of sight in the water, without an apparent motion; but their natural mode of diving is to spring with a stroke of their feet, almost clearing the water, and disappearing about three feet from the starting-point. They are at home on the waves, and it is almost impossible to force the birds to take wing; but when in the air fly with great rapidity, with neck and feet stretched out to their full extent, and in alighting, often do not attempt to slacken their speed, but strike the water with partially closed wings, with a force that carries them on the surface from twenty to forty feet.

Their nests are usually built on broken-down reeds or rushes, growing in water from two to three feet deep, and made of decayed vegetation brought up from the bottom. Eggs, two to five; dull bluish-white. A set of four eggs collected at Devil's Lake, Dakota, June 1, 1884, measured 2.20x1.47, 2.26x1.47, 2.30x149, 2.32x1.50; in form, vary from elliptical ovate to elongate ovate.

Two sets of eggs, one of four, the other of five, taken by Capt. Chas. Bendire, May 28, 1883, on a marsh in Klamath county, Oregon, average 2.31x1.52. He writes that they often lay seven eggs, and possibly more.

THE SURF SCOTER.
(*Oidemia perspicillata* Linn.)

Habitat, northern North America; south in winter to Jamaica, Florida, Ohio river, Kansas, and Lower California; accidental in Europe. A rare visitant; captured October 29, 1887, on the Kansas river, above the dam at Lawrence, by Mr. A. L. Bennett, of Emporia.

This species of the Sea Duck is abundant upon both coasts, and during the breeding season, quite common upon the large northern inland waters; breeding from Sitka, Alaska, and the Gulf of St. Lawrence north to the Arctic coast. Their food consists largely of shell-fish, (the bivalve a favorite, the shells of which appear to digest as easily as the mussels within them,) fishes and various forms of life also help to make up the bill of fare. Their flesh is coarse, and in flavor rather rank. The birds are at home as well in the surging surf as upon the smoother waters; resting and sleeping at night out upon the open waters, they rise from the same in a running, laborious manner, but when fairly on the wing, fly rapidly, and in stormy weather hug close to the water. While feeding, are very active, constantly and rapidly diving one after the other, a continual disappearing and popping up.

From the following, it appears that the birds nest upon both marshy and dry ground, and in the latter case, with no material except down, viz.: Audubon describes a nest found (near Little Macatino, Gulf of St. Lawrence) well out upon a marsh, as snugly placed amid the tall leaves of a bunch of grass, and raised fully four inches above its roots. It was composed of withered and rotten weeds, the former being circularly arranged over the latter, producing a well-rounded cavity, six inches in diameter, by two and one-half in depth. The borders of this inner cup were lined with the down of the bird, in the same manner as the Eider Duck's nest, and in it lay five eggs — 2.31x1.63 — about equally rounded at both ends, perfectly smooth, and of a pale yellowish or cream color. Mr. McFarlane* found the birds breeding in considerable numbers in the neighborhood of Fort Anderson, and desribes a nest containing eight eggs, found June 25, as placed on a ridge of ground at the foot of a dry, stunted pine, made of dark-colored down, being entirely concealed from view by the lower branches of the pine tree. All of the nests found appear to have been of the same style and pattern, and nothing is said of any other material than down being used in building them. The number of eggs varied from five to eight, but the latter number was found in only a single instance.

CLARK'S NUTCRACKER.
(*Picicorvus columbianus* Wils.)

Habitat, the high, coniferous forests of western North America; north to Alaska, south to Arizona, east to the edge of the plains; accidental in Kansas.

Mr. L. L. Jewell, of Irving, kindly sent me for examination a portion of the skin as saved from a male bird, shot August 13, 1888, by Mr. Chas. Netz, near the south

*North American Water Birds, B. B. & R., vol. 2, p. 102.

line of Marshall county. Dr. Cooper met with a straggling pair at Fort Kearney, Nebraska, and Mr. G. S. Agersborg, a pair in southeastern Dakota, but like the Kansas visitor, accidental wanderers. They are seldom found below an altitude of 4,000 feet. This bird has the actions and habits of several species. Like the jays, are at times noisy and in flocks, and when upon the ground, hop about in the same manner; it clings like the woodpeckers to the side of a tree while it hunts for, and extracts from old excavations, interstices of the bark, etc., the various forms of life found therein, and its flight is similar, and in clasping with its sharp claws the cones on the pines, and other coniferous trees, in order to pry with its bill for the seeds, it often hangs head downward, swaying back and forth, with the ease and movements of the Titmice. The birds are very shy, and, at or near their nesting-places, silent.

In May, 1879, my brother found the birds breeding near Fort Garland, Colorado. It was too late in the season for their eggs, but in one nest he found young birds; says the old bird sat very close, only leaving when touched by his hand. The nest was built near the end of a horizontal limb of a pine tree, about ten feet from the ground, in an open, conspicuous situation. It was bulky, and coarsely constructed of twigs, sticks, strips of bark, rootlets, grass, moss, etc., and very deeply hollowed; the bird, when on it, showing only part of her bill and tail, pointing almost directly upward. At a distance, would be taken for a squirrel's nest. Capt. Chas. Bendire writes me that, during the month of April, 1876–8, he found, in the vicinity of Camp Harney, Oregon, quite a number of their nests (described as above) with eggs, and gives the following dimensions of four eggs: 1.30x.92, 1.26x.95, 1.22x.95, 1.20x.90. Usual number, three; ground color, light grayish green, irregularly spotted and blotched with a deeper shade of gray, principally about the larger end; elongate oval in shape, and considerably pointed at the smaller end.

THREE NEW KANSAS BIRDS.

BY PROF. H. SNOW, OF THE UNIVERSITY OF KANSAS.

I have the pleasure of announcing the addition of three species to the catalogue of Kansas birds since the last annual meeting of the Academy. These additions are of especial interest since each of the three forms is a typical species and not a colorational or local variety of some species previously known to occur in the State.

1. The first of these birds is the Surf Duck, or Surf Scoter, *Oidemia perspicillata* Linn. A young male was shot at Lawrence, October 29, 1887, by Mr. A. L. Bennett, a student of the University. This species is abundant along both the Atlantic and Pacific coasts. It is said to be a common winter resident upon Lake Michigan, occurring throughout the State of Illinois during the winter season. Its capture at Lawrence, Kansas, extends its recorded appearance in the interior of the United States by about 400 miles. This individual appeared to be a solitary bird, entirely unaccompanied by other ducks either of its own or any other species.

2. The second addition to our bird fauna is the Western Grebe, *Æchmophorus occidentalis* Lawr. A young male of this species was shot on the Kansas river, at Lawrence, November 3, 1887, by a colored man living on the bank of the river, with whom I have an arrangement to bring in any bird of an unusual character which he may capture. This species has not previously been taken farther east than Manitoba, and the Gila river in New Mexico. Its occurrence at Lawrence extends its eastward range more than a thousand miles. The widening of the Kansas river by the Lawrence mill-dam affords a specially attractive halting-place for waterfowl. It was at the same place that the Surf Scoter was captured by Mr. Bennett only a few days

before. The Western Grebe is a much larger bird than any of the other grebes which occur in Kansas. Dr. Cooper, who has studied this grebe on the Pacific coast, remarks that it greatly resembles the loon in its habits. It can dive and swim under the water with the greatest ease, and when once risen above the surface, can fly with rapidity. It is described as being a fine-looking bird as it sits on the water, riding very lightly, its long neck erect, and its bill pointing horizontally forward. Its length of neck makes the motion during the act of diving a very peculiar one. When it flies, both its feet and neck are outstretched. The colors of certain parts which are very beautiful in life, change and fade after death.

3. The third addition to our avi-fauna is Clark's Nutcracker, *Picicorvus columbianus* Wilson. The capture of a specimen of this bird was reported to me on August 13, 1888, by Mr. L. L. Jewell, of Irving. The specimen was shot on August 12, near the south line of Marshall county, by Mr. Chas. Metz. The wings and tail were forwarded to me for identification. Mr. Jewell states that the bird had breakfasted upon a variety of seeds, not including those of the pine cone, showing that the species is capable of doing entirely without that article of food which predominates in its mountain diet.

On the 1st of October, Dr. Louis Watson, of Ellis, who has made so many contributions to our knowledge of the Kansas bird fauna, wrote to me announcing that he had certainly seen two Clark's Nutcrackers together in a narrow strip of timber on his farm. He says: "They were not wild, as I repeatedly saw them within five or six rods. I returned to the house for my gun, but did not find them in that portion of the timber through which I could drive. I am very sorry that I did not get a specimen for you. They were of a grayish color, bill rather long, and in their short flights showed a broad white stripe across the wing, and in the much-expanded tail much white exterior to a white center. There can be no doubt but the birds were *Picicorvus columbianus*, of Wilson."

I can find no record of the previous occurrence of the bird at any point east of the Rocky Mountains. The fact of its appearance in both Marshall and Ellis counties on dates more than six weeks apart, considered in connection with the well-known gregarious character of the species, indicates the probability that it entered the State in considerable numbers. This is certainly a remarkable instance of separation from natural habitat. Dr. Coues states that the range of this species is nearly coincident with that of coniferous vegetation in the West. It rarely descends below an altitude of 3000 feet above the base of the mountains, and has been observed on peaks 10,000 feet high. The omnivorous character of the bird, however, seems to give it the power of adapting itself to a new habitat. Dr. Coues states that it is an indiscriminate feeder upon vegetable substances, giving preference to the seeds of the pine, berries of the cedar, and acorns. Mr. T. M. Trippe states that it occasionally visits the slaughter-houses, and like a true crow, seems to be quite omnivorous, cramming its hungry maw with everything that will satisfy its voracious appetite.

A LIST OF THE KANSAS SPECIES OF PERONOSPORACEAE.

BY W. T. SWINGLE,

Assistant Botanist Kansas Experiment Station, Manhattan, Kansas.

This list has been prepared with the following objects in view: First, to include all species known to occur within the State. Second, to attempt to show something of the phænology of the species, though unfortunately, Kansas species have not been observed long enough to give results of much value in this line. It has been thought

best to give a list of all the specimens collected in the State, which by their number indicate something of the relative abundance of the species. Third, to give the results of an examination of all the specimens for oospores. If no mention of oospores is made immediately after the number of the specimen, it is to be understood that the specimen was examined but none were found. Fourth, to give the classification used by Schrœter in Cohn's Kryptogamen-Flora Schleseins, III Band., and adopted by Berlese and DeToni in Saccardo's Sylloge Fungorum, Vol. VII. Since I know of no American publication giving this classification, I have given descriptions of the family, genera and sub-genera, for the most part simply translations from Sylloge and Krypt. Flora. I have also included the extra limital genus *Phytophthora*, as it is very probable that it will soon be known in the State.

It will be noticed at once that several familiar names have been changed by this classification, and that I have made a few innovations myself. It is hoped that the reasons for the change given in each case will prove satisfactory. Two new species, *Peronospora Hedeomæ*, Kell. & Sw., and *Per. Cynoglossi*, Burrill, and one new variety *P. Cynoglossi*, Burrill, var. *Echinospermi* Swingle, are described.

It has not been found practicable to give any notes on the relation of the growth of *Peronosporaceæ* to the humidity of the atmosphere, though several facts of interest have been noticed. One point, however, may receive mention, as it has been scarcely regarded by other writers on this group. That is the wintering of *Peronosporaceæ* in young plants. It has been noticed for several years that some of the species could be found very late in fall and early in spring, or even during mild weather in winter on seedling plants. Sections through these affected plants showed an apparently healthy mycelium, even during the coldest weather. It requires but a few days of warm weather to produce a crop of conidia. It was also noticed that such parisitism was very destructive to the host plants, a very large per cent. dying in early spring.

Only the following species (all of the genus *Peronospora*, it will be noticed) have been found passing the winter in seedling plants: *Peronospora Arenariæ*, var. *macrospora*, *P. Arthuri*, *P. Corydalis*, *P. parasitica* and *P. Hedeomæ*.

All of the thirty-two species included in this list were collected from August, 1888, to October, 1889, by Prof. W. A. Kellerman or myself, unless otherwise specified. The numbers given, unless preceded by the name of some collector, should be cited: Kellerman and Swingle.

The species are arranged in the genera, or sub-genera, according to the host plants — following Bentham and Hooker's Genera Plantarum.

In all cases the original descriptions have been cited, and the more important synonyms given. I have also given, in brackets following these citations, the references to American descriptions, and to Saccardo's Sylloge.

All of the specimens of any species collected on one plant are given immediately after its name, and arranged according to the time of the year the collection was made. These references to specimens give the number, date, and locality, and also tell the part of the plant attacked.

All of the numbers mentioned in this list are in my herbarium, and also that of Prof. Kellerman. All of the species are in the herbarium of the Kansas State Agricultural College.

In conclusion, I thank Prof. W. A. Kellerman for the use of his books and collections, without which the list in its present form would not have been possible. To Mr. J. B. Ellis, Dr. B. D. Halsted, Dr. T. J. Burrill, Prof. W. G. Farlow, Mr. W. C. Stevenson, jr., Prof. M. A. Carleton, Mr. E. Bartholomew, and Miss May Varney, I owe thanks for many favors.

I give in conclusion a list of writings and exsiccate containing references to Kansas species.

BIBLIOGRAPHY OF WORKS REFERRING TO KANSAS PERONOSPORACEAE.

(*a*) WRITINGS.

I. A Partial List of the Kansas Parasitic Fungi, together with their Host Plants, by W. A. Kellerman, Ph. D. In Trans. of 16th and 17th Ann. Meetings Kansas Acad. Sci., vol. IX (1883–1884), pp. 79–86. (1885.) (Reprinted in Bulletin No. 2 of the Washburn College Lab. of Nat. Hist., January, 1885, pp. 72–81.)

Includes (p. 83) 11 species on 15 host plants.

II. New Kansas Fungi, by J. B. Ellis and W. A. Kellerman. In Journal of Mycology, vol. I, pp. 2–4. (1885.)

Describes (p. 2) *Peronospora Oxybaphi*, E. & K.

III. Second List of Kansas Parasitic Fungi, together with their Host Plants, by W. A. Kellerman, Ph. D., and M. A. Carleton. In Trans. of 18th and 19th Ann. Meetings Kansas Acad. Sci., vol. X (1885–1886), pp. 88–99. (1887.)

Includes (pp. 94 and 95) 14 species on 22 host plants; includes those given in I and II.

IV. New Kansas Fungi, by J. B. Ellis and W. A. Kellerman. In Journal of Mycology, vol. III, pp. 102–105. (1887.)

Describes (p. 104) *Peronospora Swinglei*, E. & K.

V. New Species of Fungi from Kansas, by J. B. Ellis and W. A. Kellerman. In Journal of Mycology, vol. III, pp. 126, 127.) (1887.)

Describes (p. 126) *Peronospora Lini*, E. & K.

VI. Notes on Fungi from Western Kansas, U. S. A., by W. T. Swingle. In Journal of Mycology, vol. IV, pp. 27–29. (1888.)

Includes (p. 29) one species "*Peronospora Effusa* (Grev.), on *Chenopodium album* L., Cloud county, Kas.," collected by M. A. Carleton.

VII. Sylloge Fungorum Omnium hucusque cognitorum, digissit P. A. Saccardo, VII. (Pars. I.) Phycomyceteae auctoribus, Doct. A. N. Berlese et J. B. De Toni, *Peronosporaceae*, pp. 233–264. (1888.)

Includes descriptions of all species, and Kansas is given as locality for *Peronospora Oxybaphi*, E. & K.

VIII. Report of the Department of Agriculture for the year 1888. Report of the chief of the Section of Vegetable Pathology, pp. 325–404, by B. T. Galloway.

A map at the end of the report, showing the distribution and severity of the Potato Rot, shows the disease to be reported from Kansas and destroying 0–7 per cent. of the crop.

(*b*) EXSICCATÆ.

IX. J. B. Ellis, North American Fungi, and J. B. Ellis and B. J. Everhart, North American Fungi, second series.

X. Robenhorst-Winter, Fungi Europæi.

XI. C. Romeguere, Fungi Gallici Exsiccati, and Fungi Selecti Exsiccati.

XII. Kellerman and Swingle, Kansas Fungi.

Fam. PERONOSPORACEAE De Bary.

(*Peronosporeae.*)

Hyphae commonly branched, conidia mostly producing zoospores, sometimes germinating directly; reproduction both asexual by conidia and sexual by oogonia and antheridia. Air-loving fungi, parasitic on living plants — mostly found on leaves. [Sacc. Syll. vol. VII., pp. 182 and 233.]

ANALYTICAL KEY TO THE GENERA.

A) Conidiophores short, produced inside of the host. Conidia catenulate.

1. *Cystopus.* Conidia and oospores producing zoospores.

B) Conidiophores arising from the host through fissures. Conidia solilary.

† Conidiophores sparingly branched, at first producing conidia acrogenously, then also on the sides.

Phytophthora. Conidia producing zoospores.

†† Conidia always acrogenous.

§ Conidiophores with rather short, obtuse terminal branches. Conidia never germinating directly, but by zoospores or by discharging the whole protoplasm.

Sclerospora. Wall of oospore thick. Germination by zoospores.

Plasmopara. Wall of oospore thin. Conidia producing zoospores or discharging (before germination) the whole protoplasm.

§§ Conidiophores many times dichotomously branched, terminal branches subulate uncinate. Conidia germinating directly.

Bremia. Haustoria not branched. Conidia germinating through an apical papilla.

Peronospora. Haustoria branched, conidia destitute of an apical papilla, germinating laterally.

CYSTOPUS Leveille, in Ann. Sci. Nat., ser. 3, t. VIII, p. 371. [Bull. Bussey Inst., vol. I, p. 429. Bot. Gaz., vol. VIII, p. 334. Syll., vol. VII, p. 233.]

Conidiophores simple, smooth, cylindrical, or clavate, very obtuse, arising as branches from the mycelium and collected in large numbers in cushion-shaped sori, bearing a single apical moniliform series of conidia. Sori at first covered by the epidermis of the host plant, then bursting open the epidermis and scattering the mature conidia, either white or yellowish. Conidia either all of the same form, hyaline, generating zoospores, or of two forms, mostly hyaline and producing zoospores, but with a few at the ends of the chains with a thicker, often lutescent wall, either germinating by a simple tube or sterile. Oospores globose, epispore mostly reticulate or warty.

§ I. Exosporium thick, plainly four-layered; conidia globose or rounded quadrate (short cylindrical).*

1. **Cystopus candidus** (Pers.) Lev., in Ann. Sci. Nat., ser. 3, t. VIII, (1847) p. 371, UREDO (ALBUGO) CANDIDA, Pers. Synops. Meth. Fung., p. 223. [Bull. Bussey Inst., vol. I, p. 429. Bot. Gaz., vol. VIII, p. 334. Syll., vol. VII, p. 234, No. 792.]

Conidia and oospores on leaves, stems and inflorescences of *Cruciferae* March to August, most common April and May.

On *Draba Caroliniana* Walt.

1512, with immature oospores, on leaves, May 1, 1888, Manhattan. (*Peronospora parasitica*, No. 1512*a*, occurs on the lower leaves of the same plants.)

On *Sisymbrium canescens* Nutt.

1580, on leaves, March 26, 1889, Manhattan; 1616, on leaves, March 29, 1889, Manhattan; 1537, on leaves, April 4, 1889, Manhattan; 1596, on leaves, April 22, 1888, Manhattan; 1533, on leaves, April 25, 1889, Manhattan (*Peronospora parasitica* No. 1533*a* occurs on leaves and stems of the same plants); 1516, on leaves, May 4, 1885, Manhattan; E. Bartholomew No. 294, on leaves, with very young oospores, May 27, 1889, Rooks county.

* Zalewski Zur Kenntniss der Gattung Cystopus, Lev., in Botanisches Centralblatt, Band XV, (1883.) No. 7 (33), S. 222.

On *Sisymbrium officinale* Scop.

1599, on leaves, June 18, 1889, Manhattan; 1657, on leaves, July 3, 1889, Manhattan; 1530, on leaves, July 30, 1887, Lawrence.

On *Nasturtium Armoracia* Fries.

1517, on leaves, May 20, 1885, Manhattan; 1504, on leaves, 1883; 1631, on leaves, June 29, 1889, Manhattan (a *Septoria* occurs on the upper side of the spots caused by the *Cystopus*); 446, on leaves, August 10, 1883, Manhattan.

On *Nasturtium sessiliflorum* Nutt.

M. A. Carleton No. 102, on leaves, May 18, 1888, Cloud county; 1521, on leaves, May 22, 1887, Manhattan; 1503, on leaves, May 31, 1884, Zeandale, Riley county.

On *Capsella Bursa-pastoris* Moench.

1506, on stems, pedicels, and seed-pods, May 20, 1886, Manhattan; 1538, on stems, pedicels, and seed-pods, June 6, 1889, Manhattan.

On *Brassica Nigra* Koch.

1650, with very abundant mature oospores in the ends of the stems and pedicels, and even flowers, causing considerable distortion, no conidia, July 4, 1889, Manhattan.

On *Lepidium intermedium* Gr.

1536, on leaves, April 4, 1889, Manhattan; 1518, on leaves, April 5, 1888, Manhattan; 1529, on leaves, April 5, 1889, Manhattan; 1665, on leaves, April 6, 1889, Manhattan; 1534, with mature oospores, on leaves, April 25, 1889, Manhattan; E. Bartholomew, No. 293, with young oospores, on leaves, May 27, 1889, Rooks county (*Peronospora parasitica*, No. 293*a*, also occurs on the same plants); 1522, with mature oospores, on leaves, June 1, 1887, Manhattan.

On *Lepidium Virginicum* L.

1505, with young oospores (?), on leaves, May 4, 1884, Manhattan.

On *Raphanus sativus* L. (cult. Radish).

446*a*, on leaves, May 30, 1885, Manhattan.

2. **Cystopus Ipomoeae-panduranae** (Schw.) Stevs. & Sw. ÆCIDIUM IPOMOEAE-PANDURANAE, Schw. Syn. Fung. Carol., No. 454. CAEOMA (ÆCIDIUM) CONVOLVULATUM, Schw. Syn. Fung. Am. Bor., p. 292, No. 2866. CYSTOPUS CONVOLVULACEARUM, Otth. sec. Zalewski in Bot. Centralb., XV Band, (1883) S. 223. CYSTOPUS CONVOLVULI, Otth. (?). CYSTOPUS CONVOLVULACEARUM, Speg. (?) Fungi Guarantici, Pug. I, No. 163. CYSTOPUS CUBICUS, Auct., p. p.

Conidia on leaves, petioles, stems, and calyces, and oospores only in stems,* of *Convolvulaceae* June to September; most abundant during July and August.

On *Ipomoea hederacea* Jacq.

1507, on leaves, June 11, 1886, Manhattan; 1635, on leaves, July 18, 1887, Mound City; 1792, on leaves and stems, August 1, 1889, Manhattan; 1539, on leaves, August 15, 1887, Manhattan; 1540, on leaves, August, 1886, Manhattan; 1669, on leaves, stems, and flowers, August 18, 1889, Stockdale, Riley county; 1520, (Coll. D. G. Fairchild,) on calyces and leaves, September 6, 1887, Manhattan; 1879, with a few mature oospores on stem just below calyx, September 28, 1889, Manhattan.

On *Ipomoea lacunosa* L.

1765, on leaves, August 28, 1889, Manhattan.

* Dr. B. D. Halsted sends me specimens collected on Ipomoea pandurata at Millstown, N. J., Sept. 3, 1889, which have many oospores in the leaf spots, and in swellings of the petiole.

On *Ipomoea leptophylla* Torr.

642, conidia on leaves and stems, oospores abundant in stems, August 20, 1884, Garden City, Finney county.

On *Ipomoea pandurata* Meyer.

1008, conidia on leaves, petioles, and stems, oospores only in stems, mature mature, July 18, 1887, Mound City.

Mr. W. C. Stevenson, jr., of Philadelphia, has compared Kansas specimens with the original specimen of *Æcidium Ipomomeae-panduranae* in the Schweinitzian Herbarium, and pronounces the conidia and oospores identical in both. The oospores of this species are very different from those of *Cystopus Trapopogonis*, to which it has been referred by many writers. They are sub-globose or slightly oval, yellow or yellowish brown, about 40–50μ diam., with a very thick (about 5–8μ) wall; epispore thick, colored, marked with thick, blunt, rather sparse tubercules; oogonia rather closely fitting the oospores, about 50–65μ diam., hyaline, with irregular, abundantly sinuose-tuberculate ridges, or folds.

The epispore often comes off the oospore and remains in the oogonium when it is crushed. When wanting the epispore, the oospores are seen to be hyaline, and to have a thick inner wall. The antheridia can be plainly seen, even in mature specimens, attached to the outside of the oogonia, and connected with the oospores by a thick, short, colored tube.

A few oospores were seen which seemed to be abortive. Instead of containing a single large oospore, the oogonium contained several small thick-walled yellow spheres.

3. **Cystopus Portulacae** (DC.) Lev., in Ann. Sci. Nat., ser. 3, t. VIII (1847), p. 371. UREDO PORTULACAE DC. Fl. Franc., vol. II, p. 88; vol. VI, p. 68. [Bot. Gaz., vol. VIII, p. 336; Syll., vol. VII, p. 235, No. 795.]

   Conidia and oospores on leaves and capsules of *Portulacaceae* June to October; most abundant in July and August.

On *Portulacea oleracea* L.

1601, June 21, 1889, Manhattan; 1509, July 20, 1886, Manhattan; 1767, on leaves, July 27, 1889, Manhattan; M. A. Carleton No. 161, with mature oospores, July, 1886, Cloud county; 1515, August 21, 1885, Kinsley, Edwards county; 418, August 31, 1883, Manhattan; 1895, on leaves and capsules, with mature oospores, October 15, 1889, Manhattan.

4. **Cystopus Trapopogonis** (Pers.) Schroeter, in Cohn. Krypt. Flor. Schles., III Band S. 234, No. 348. *Uredo candida* Pers., var. B. UREDO TRAPOPOGI Pers. Syn. Meth. Fung., p. 223. CYSTOPUS CUBICUS (Strauss) Lev., in Ann. Sci. Nat., ser. 3, t. VIII. UREDO CUBICA Strauss, in Ann. Wetterauer Ges. f. Naturk., vol. II, p. 86; pl. 2, f. 3. [Bull. Bussey Inst., vol. I, p. 429; Bot. Gaz., vol. VIII, p. 335; Syll., vol. VII, p. 234, No. 793.]

   Conidia and oospores on leaves, stems and inflorescence of *Compositae Tubuliflorae* June to August, most abundant June and July.

On *Iva ciliata* Willd.

M. A. Carleton No. 158, on leaves and sparingly on inflorescence, August 20, 1886, Cloud county.

On *Ambrosia artemisiaefolia* L.

1587, on leaves, June 6, 1889, Manhattan; 1593, on leaves, June 9, 1889, Manhattan; 1167, on leaves, June, 1887, Manhattan; 1764, oospores and conidia on leaves, July 30, 1889.

On *Ambrosia psilostachya* DC.

E. Bartholomew No. 347, on leaves, oospores mature, July 27, 1889, Rooks county; M. A. Carleton No. 159, on leaves, stems, and inflorescence, oospores abundant and mature, August, 1886, Cloud county; 1785, oospores and a few conidia on leaves, August 18, 1889, Manhattan.

On *Ambrosia trifida* L.

1168, on leaves, June 9, 1887, Manhattan.

5. **Cystopus Amaranti** (Schw.) Berkeley, Notices of N. A. Fungi, No. 571 in Grev., vol. III, p. 58. CÆOMA (UREDO) AMARANTHI Schw. Syn. Fung. Am. Bor., p. 292, No. 2853. CYSTOPUS AMARANTACEARUM Zalewski, in Bot. Centralb., XV Band, S. 223. CYSTOPUS BLITI, Auct. p. p. [Bull. Bussey Inst., vol. I, p. 429; Bot. Gaz., vol. VIII, p. 335; Syll., vol. VII, p. 235, No. 797.]

Conidia and oospores on leaves of *Amarantaceae* May to September, most abundant June and July.

On *Amarantus albus* L.

1605, June 9, 1889, Manhattan.

On *Amarantus blitoides* Wats.

1602, May 26, 1889, Manhattan; 1592, June 8, 1889, Manhattan; 1603, June 10, 1889. Manhattan.

On *Amarantus retroflexus* L.

1589, June 10, 1889, Manhattan; M. A. Carleton No. 160, June 11, 1886, Cloud county; 1541, June 15, 1886, Manhattan; 1622, oospores abundant, mature, June 29, 1889, Manhattan; 962, oospores mature and very abundant, conidia very scarce, July 8, 1887, Manhattan; 1511, oospores mature, abundant, conidia wanting, July 8, 1887, Manhattan; 962*a*, oospores mature, conidia very scarce, July 9, 1887, Manhattan; 1514, July 18, 1887, Mound City, Linn county; 1769, July 27, 1889, Manhattan; 426, July 31, 1883, Manhattan; 1660, August 2, 1883, Manhattan; 1874, with mature oospores, September 8, 1889, Manhattan.

I have followed Zalewski* in separating this species from *Cystopus Bliti* (Biv.) De Bary.

PHYTOPHTHORA De Bary. Researches into the Nature of the Potato Fungus, in Journ. Roy. Ag. Soc., second series, vol. XII (1876), pp. 239–269. [Bot. Gaz., vol. VIII, p. 309; Syll., vol. VII, p. 237.]

Mycelium growing in and killing the cells of the host, furnished with but few if any haustoria; conidiophores usually sparingly branched. Conidia at first acrogenous, then produced on the sides of the conidiophores; ovate, papillate at the apex, producing zoospores. Oospores globose, epispore rather smooth, brown.

Phytophthora infestans (Mont.) De Bary, Researches into the Nature of the Potato Fungus, in Journ. Roy. Ag. Soc., second series, vol. XII (1876), pp. 239–269. BOTRYTIS INFESTANS Mont. Mem. l' Inst., 1845, p. 113; Syll., p. 302. [Bull. Bussey Inst, vol. I, p. 426; Bot. Gaz., vol. VIII, p. 309; Syll., vol. VII, p. 237, No. 802.]

This species, the cause of "Potato Rot," has not, to my knowledge, been collected within the limits of Kansas by any mycologist. It is, however, reported from Iowa,† and in the Annual Rep. of the Dept. of Agriculture for 1888: Rep. of the Chief of the Sec. of Veg. Path. A map showing the distribution of the

* Bot. Centralbl. l. c.

† Bull. from the Bot. Dept. of the Iowa Ag. Coll., 1886; Bull. No. 1 from the Lab. of Nat. Hist. of the State Univ. of Iowa (1888).

"Potato Rot" reports its occurrence in the southern and northern portions of Kansas. It also gives the potato crop as injured to the extent of 0 to 7 per cent. by the Rot. It is therefore very probable that this species occurs in the State.

SCLEROSPORA Schroeter, in Cohn Krypt. Flora Schles., III Band, S. 236. PERONOSPORA Subg. SCLEROSPORA Schroeter. In Hedw., vol. VIII (1879), pp. 83–87. [Syll., vol. VII, p. 238.]

Conidiophores erect, furnished with few branches; conidia ovate, emitting the zoospores through an apical papilla. Oospores globose, with a very thick, many-layered, brown, epispore.

6. **Sclerospora graminicola** (Sacc.) Schroeter, in Cohn. Krypt. Flora Schles., III Band, S. 236, No. 352. PROTOMYCES GRAMINICOLA Sacc. Fungi Veneti Novi vel Critici, ser. V., No. 91, in Nuovo Gior. Bot. Ital., vol. VIII (1876), p. 172; Mycothecia Veneta No. 496. USTILAGO (?) URBANI Magnus, in Verhandl. der Bot. Ver. der Provinz Brandenburg, 1878, p. 52. PERONOSPORA SETARIA Passerini, in Grevillea, vol. VII (1878), p. 99. PERONOSPORA GRAMINICOLA Saccardo, in Michelia, No. VIII, p. 586. [Bot. Gaz., vol. IX, p. 39; Syll., vol. VII, p. 238, No. 804.]

Oospores and conidia (?) on leaves and inflorescence of *Gramineae* August.

On *Setaria Italica* L. (New Golden Wonder Millet.)

1772, oospores alone, on leaves and inflorescences, August 17, 1889, Manhattan; 1871, oospores and seemingly a few conidia, though no conidiophores could be seen, on leaves and inflorescence, August 24, 1889, Manhattan.

On *Setaria Italica* Kth., var. *Germanica.* (Hungarian Grass.)

1872, oospores only, on leaves and inflorescence, August 24, 1889, Manhattan.

This species did considerable damage to a plot of New Golden Wonder Millet and some Hungarian Grass mixed with it, on the Kan. State Ag. Coll. farm.

PLASMOPARA Schroeter, in Cohn. Krypt. Flor. Schles., III Band, S. 236. [Syll., vol. VII, p. 239.] BASIDIOPHORA Roze & Cornu. GILLETIA Sacc. & Penz. PERONOSPORA § ZOOSPOREIPARAE and § PLASMATOPARAE De Bary.

Mycelium thick, furnished with minute, simple vesiculose or ovate haustoria; conidiophores erect, sparingly [usually pinnately,] branched; conidia mostly papillate; oospores globose, epispore, light brown, smooth.

7. **Plasmopara Geranii** (Peck) Berl. & De Toni, in Sacc. Syll., vol. VII, p. 242, No. 811. PERONOSPORA GERANII Peck. 28th Rep. N. Y. State Mus., p. 63. PERONOSPORA NIVEA Ung., var. GERANII Farlow, in Bull. Bussey Inst., vol. I, p. 426; [Bot. Gaz., vol. VIII, p. 311.]

On leaves of *Geraniaceae* May.

On *Geranium Carolinianum* L.

M. A. Carleton No. 97, May 11, 1888, Wichita, Sedgwick county.

8. **Plasmopara viticola** (B. & C.) Berl. & De Toni, in Sacc. Syll., vol. VII, p. 239, No. 806. PERONOSPORA VITICOLA B. & C. Grev., vol. III, p. 109. PERONOSPORA VITICOLA (B. & C.) De By. Ann. Sci. Nat., ser. 4, t. XX, p. 165. BOTRYTIS VITICOLA B. & C. (name only). [Bull. Bussey Inst., vol. I, p. 427; Bot. Gaz., vol. VIII, p. 309.]

On stems and leaves of *Ampelidaceae* June to October, most abundant from July to October, rather common.

On "Pearl" grape (*Vitis sp. cult.*).

460, on leaves, August 16, 1883, Manhattan.

On *Vitis riparia* Mx.

1528, on leaves and stems, June 10, 1886, Manhattan; 1569, on leaves, July 7, 1887, Mound City, Linn county; 1800, on leaves, September 1, 1889, Manhattan; 678, on leaves, October 4, 1884, Manhattan (*Phoma ustulatum* B. & C. also occurs on the same leaves); M. A. Carleton No. 38, on leaves, October 9, 1887, Cloud county.

NOTE.—During the last week of August, 1889, the experimental vineyard of the Kansas State Agricultural College, at Manhattan, was examined for *Plasmopara viticola*. Thinking that the result might be of value as showing which varieties were most affected,* I have given the horticultural name of the variety, the species from which it is derived, according to the "Bushberg Catalogue" for 1883, and also the estimated damage on a scale of 100, in figures immediately following the name of the variety.

Varieties derived from *Vitis æstivalis* Mx. On leaves.

1808. *Eumelan* (15). August 31.
1807. *Lenoir* (10). August 31.

Varieties derived from *Vitis Labrusca* L. On leaves.

1838. *Catawba* (20). August 29.
1837. *Concord* (20). August 29.
1831. *Cottage* (15). August 31.
1835. *Creveling* (30). August 29.
1836. *Diana* (30). August 29.
1834. *Dracut Amber* (8). August 29.
1832. *Eaton's Seedling* (20). August 31.
1833. *Early Victor* (8). August 29.
1813. *Hartford Prolific* (2), oospores mature, scarce. August 31.
1816. *Iona* (10), oospores immature. August 31.
1817. *Isabella* (10), oospores mature, very scarce. August 31.
1814. *Ives* (1), oospores scarce. August 31.
1810. *Lady* (20), oospores very scarce. August 31.
1818. *Martha* (5). August 31.
1812. *Mason's Seedling* (30). August 31.
1811. *Maxatawney* (10). August 31.
1865. *Miles* (10). August 31.
1828. *Norfolk* (8). August 31.
1820. *Perkins* (10), oospores immature. August 31.
1827. *Pocklington* (10). August 31.
1830. *Prentiss* (15), oospores mature. August 31.
1826. *Rebecca* (20). August 31.
1821. *Venango* (5), oospores nearly mature. August 31.
1825. *Vergennes* (15). August 31.
1822. *Worden's Seedling* (15). August 31.
1824. *Wyoming Red* (15). August 31.

HYBRID VARIETIES.—On leaves.

1844. *Agawam* (5). August 29.
1849. *Amber Queen* (10). August 31.
1854. *Amminia* (10). August 29.
1861. *August Giant* (5). August 29.
1843. *Beauty* (15). August 29.

* The following varieties were not attacked by *Plasmopara*:

Bacchus.	*Clinton.*	*Duchess.*	*Empire State.*	*Goethe.*	*Norton's Va.*	*Swing.*
Barry.	*Cynthiana.*	*Elvira.*	*Gazelle.*	*Herbert.*	*Peter Wylie.*	*Ulster's Prolific.*

1839. *Black Eagle* (1). August 29.
1857. *Brant* (1), oospores mature, scarce. August 31.
1841. *Brighton* (25). August 29.
1809. *Centennial* (20). August 31.
1863. *Croton* (20), oospores nearly mature, scarce. August 29.
1842. *Delaware* (40). August 29.
1903. *Downing* (20). September 6.
1858. *El Dorado* (1). August 31.
1806. *Etta* (25). August 31.
1840. *Eva* (8). August 29.
1862. *Faith* (10). August 29.
1860. *Grein's Golden* (15). August 29.
1851. *Highland* (25). August 31.
1804. *Humboldt* (15). August 31.
1845. *Iowa Excelsior* (20). August 31.
1815. *Jefferson* (20), oospores mature, very scarce. August 31.
1802. *Marion* (20). August 31.
1855. *Massasoit* (25). August 31.
1859. *Merrimac* (1). August 31.
1805. *Montefiore* (15). August 31.
1856. *Missouri Reissling* (10), oospores very scarce. August 31.
1866. *Moyer* (25). August 31.
1853. *Naomi* (40). August 31.
1803. *Noah* (5). August 31.
1819. *Niagara* (15), oospores mature, very scarce. August 31.
1868. *Potter's Sweet* (15), oospores mature, scarce. August 31.
1801. *Pearl* (8). August 31.
1852. *Salem* (5). August 31.
1850. *Triumph* (10). August 31.
1829. *Walter* (25), oospores mature, scarce. August 31.
1848. *Wilder* (10). August 31.
1823. *Woodruff Red* (8), oospores mature, scarce. August 31.

VARIETIES OF DOUBTFUL ORIGIN.—On leaves.

1846. *Jessica* (8). August 31.
1847. *Lindly* (50). August 31.
1867. *Moore's Diamond* (25). August 31.
1864. *Rochester* (40). August 31.

9. **Plasmopara australis** (Speg.) Swingle. PERONOSPORA AUSTRALIS Speg. Fungi Argentini, Pugillus IV., p. 36, (reprinted in Trelease Prelim. List, Wisc. Par. Fungi, p. 6.) PERONOSPORA SICYICOLA Trelease in Farlow Enum. of the Per. of the U. S., in Bot. Gaz., vol. VIII, p. 331. [Syll. VII, p. 260, Nos. 870 and 871.]

Oospores and conidia on leaves of *Cucurbitaceae* June to September; most common in June and July.

On *Echinocystis lobata* T. and Gr.

1564, September 25, 1887, Manhattan; 1655, July 1, 1889, Manhattan.

On *Sicyos angulatus* L.

M. A. Carleton No. 124, June 2, 1888, Cloud county; 1615, June 15, 1884, Manhattan; 1501, oospores rather immature, very scarce. They were seen in considerable numbers in one small spot in one of the oldest leaves examined. They were nearly colorless (from immaturity?), globose, 35–40μ diam., epispore thin, apparently smooth,

wall of oogonium thin, nearly smooth, closely fitting the oospore, June 20, 1884, Manhattan; 1583, June 24, 1887, Manhattan; 1656, July 1, 1889, Manhattan; July 18, 1887, Mound City, Linn county; 1766, August 6, 1889, Manhattan; 466 and 467, August 20, 1883, Manhattan; (Exs. Rabh. Wint. Fungi Europaei, No. 3276*a*, August 28, 1883, Manhattan); 1648, August 28, 1887, Manhattan; M. A. Carleton No. 162, September 16, 1884, Manhattan.

This species is undoubtedly a good *Plasmopara*. The branching of the conidiaphores is of the common pinnate type; the oospores are light-colored with a smooth exospore, and the conidia, according to Trelease,* are furnished "with an apical papilla, hence probably germinating by zoospores."

10. **Plasmopara Halstedii** (Farlow) Berl. & DeToni, in Sacc. Syll., vol. VII, p. 242, No. 810. PERONOSPORA HALSTEDII Farlow, Notes on Some Species in the Third and Eleventh Centuries of Ellis's North American Fungi, in Proc. Am. Acad. of Arts and Sci., vol. XVIII, p. 72. [Bot. Gaz., vol. VIII, p. 310.]

Oospores and conidia on leaves of *Compositae Tubuliflorae* May to August and October; most abundant May to July. Very common.

On *Vernonia Baldwinii* Torr.

543, June 5, 1884, Manhattan.

On *Eupatorium ageratoides* L. f.

1793, August 1, 1889, Manhattan.

On *Silphium integrifolium* Mx.

1591, with immature oospores, June 9, 1889, Manhattan; 1621, June 28, 1889, Manhattan; 1763, July 20, 1889, Manhattan; 525, July 23, 1886, Manhattan; (Exs. Fungi Europaei No. 3279, August, 1884, Manhattan); 606, August 5, 1884, Manhattan; 1790, August 11, 1889, Manhattan; 1768, with mature oospores, August 12, 1889, Manhattan; 1788, with a few mature oospores, August 21, 1889, Manhattan; 1898, with nearly mature oospores, September 26, 1889, Manhattan.

On *Ambrosia artemisiaefolia* L.

1559, June 2, 1887, Manhattan; 1604, June 14, 1889, Manhattan; 1627, June 30, 1887, Manhattan.

On *Ambrosia psilostachya* DC.

1641, July 2, 1889, Manhattan; 1798, July 10, 1889, Manhattan; E. Bartholomew No. 348, July 27, 1889, Rooks county; 1773, August 5, 1889, Manhattan.

On *Ambrosia trifida* L.

1594, April 23, 1889, Manhattan; M. A. Carleton No. 99, May 11, 1888, Wichita, Sedgwick county, 1526, May 26, 1886, Manhattan; 1570, May 28, 1887, Manhattan; 533, May, 1884, Manhattan; M. A. Carleton No. 99*b*, June 1, 1888, Cloud county; 1670, oospores immature, June 1, 1889, Stockdale, Riley county; 1585, June 9, 1889, Manhattan; (Exs. N. A. F. No. 1403*d*, June, 1884, Manhattan); M. A. Carleton No. 163, June 19, 1886, Cloud county; 1662, July 5, 1884, Manhattan; 1897, September 26, 1889, Manhattan.

On *Helianthus annuus* L. (Cultivated Sunflower).

1797, July 10, 1889, Manhattan.

On *Helianthus grosse-serratus* Martens.

1638, May 22, 1889, Manhattan; 1796, with a few mature oospores, May, 1889, St. George, Pottawatomie county.

*Preliminary List of the Par. Fungi of Wisc., in Trans. Wisc. Acad. Sci. Arts and Lett., vol. VI, 1881-84.

On *Helianthus doronicoides* Lam.

522, May 25, 1884, Manhattan (Exs. Fungi Europaei No. 3278, N. A. F. No. 1403c, both collected May, 1884, Manhattan); 1524, July 27, 1886, Manhattan.

On *Helianthus tracheliifolius* Willd.

1584, August, 1886, Manhattan; 1581, October 4, 1884, Manhattan; 1900, September 26, 1889, Manhattan.

On *Bidens frondosa* L.

963, July 1, 1887, Manhattan; 1899, September 1, 1889, Manhattan.

On *Bidens connata* Muhl.

964, July 11, 1887, Manhattan.

This is probably our most abundant species. Though so common, no oospores have been found except on *Silphium integrifolium* Mx. (Nos. 1591, 1768, 1788, and 1898), and *Ambrosia trifida* L. (No. 1670).

11. **Plasmopara** *sp.* PERONOSPORA KELLERMANI Ell. & Halsted pro tem., in Ellis & Everhart North American Fungi, No. 2201.

Oospores and conidia on leaves of *Compositae Tubuliflorae* June to August.

On *Iva Xanthiifolia* Nutt.

904, June, 1887, Manhattan; (Exs. N. A. F. No. 2201, June, 1887, Manhattan); 1647, August 20, 1887, Manhattan; 1666, July 4, 1889, Manhattan; B. D. Halsted No. —, with abundant oospores in the folds or ridges, July (?), 1887, Manhattan.

This species has not yet been published, but seems to be a *Plasmopara* allied to *P. entospora*, from which it differs in having shorter fasciculate conidiophores and almost sessile conidia, which are smaller than in some forms of *P. entospora*. It is a very abundant and curious species, as yet little understood.

BREMIA Regel, in Bot. Zeit., 1843, p. 665. [Syll., vol. VII, p. 243.]

Mycelium furnished with vesiculiform or simple clavate haustoria. Conidiophores many times dichotomously branched, branches umbellate, the ultimate ones ending in a clavate or conical body from which radiate 2–8 short, subulate-conical sterigmatia. Conidia globose, depressed papillate at the apex. Oospores globose, minute; epispore slightly roughened, yellowish or dusky.

12. **Bremia Lactucae**, Regel, in Bot. Zeit. 1843, p. 665, t. 3, fig. B. PERONOSPORA GANGLIFORMIS (Berk.) DeBy. Ann. Sci. Nat., Ser. 4., t. XX, p. 108. BOTRYTIS GANGLIONIFORMIS Berk., in Journ. Hort. Soc., Lond., vol. I, p. 31, t. 4, fig. 25. [Bull. Bussey Inst., vol. I, p. 427; Bot. Gaz., vol. VIII, p. 313; Syll., vol. VII, p. 244, No. 816.]

On leaves of *Compositae Liguliflorae* May to July; most abundant May and June.

On *Lactuca Canadensis* L.

1609, May 23, 1889, Manhattan; 1500, May 25, 1885, Manhattan; 1661, June 5, 1884, Manhattan; 1623, June 23, 1889, Manhattan; 1648, July 3, 1889, Manhattan; 1902, October 23, 1889, Burlingame, Osage county.

PERONOSPORA Corda, Icones Fung., vol. I, p. 20. [Bull. Bussey Inst., vol. I, p. 426; Bot. Gaz., vol. VIII, p. 309; Syll., vol. VII, p. 244.] Mycelium furnished with filiform or branching haustoria. Conidiophores solitary or fasciculate, arising through stomata of the host plant, cylindrical, many times dichotomously branched, terminal branches mostly acute, incurved or unciuate-subulate. Conidia ovate or elliptical, destitute of an apical papilla, germinating by a lateral tube.

§ *Calothecae* DeBary. [Syll. VII, p. 245.] Oospores with a verrucose or reticulate folded epispore. Mycelium mostly furnished with round, tubular, filiform, branching haustoria.

13. **Peronospora Viciae** (Berk.) DeBary, in Ann. Sci. Nat., Ser. 4, t. XX, p. 112. BOTRYTIS VICIAE Berk., in Journ. Hort. Soc., Lond., vol. I, p. 81, t. 4, fig. 23. [Syll., vol. VII, p. 245, No. 819.]

Conidia and oospores on leaves of *Leguminosae Papilionaceae*, May and June.

On *Vicia Americana* Muhl., var. *Linearis*, Wats.

1565, (coll. by Mr. E. C. Coburn,) May 17, 1888, Zeandale, Riley county; M. A. Carleton No. 109, oospores mature, June 4, 1888, Cloud county.

14. **Peronospora Arenariae** (Berk.) Tul., in Compt. rend. Acad. des. Sci., t. XXXVIII (1854). BOTRYTIS ARENARIAE Berk., in Journ. Hort. Soc., Lond., vol. I, p. 31, t. 4, fig. 22; in Ann. and Mag. Nat. Hist., Ser. 2, vol. VII.

Var. **macrospora** Farlow, in Bot. Gaz., vol. IX, p. 38.

On leaves of *Caryophylleae* November. Rare.

On *Silene antirrhina* L.

1130, on under sides of leaves of seedling plants, November 10, 1887, Manhattan.

The identification of this specimen is somewhat doubtful, as no oospores could be found. The conidiophores seemed quite different from those of *P. alsinearum*, but I had no specimens of *P. arenariae* for comparison.

15. **Peronospora Lini** Schroeter, in Bericht über die Thätigk. der bot. Sect. der Schles. Ges., J. 1865, S. 36.* PERONOSPORA LINI E. & K., in Journal of Mycology, vol. III, p. 126.

On leaves and stems of *Lineae*, August.

On *Linum sulcatum* Riddell.

1077, August 20, 1887, Manhattan.

Since no oospores have been found in the Kansas specimens, it is not certain that *P. Lini* E. & K. is a synonym of Schroeter's species. At any rate, the name *Peronospora Lini* E. & K. cannot stand. The species seems to be very rare at Manhattan, specimens having been found but once.

16. **Peronospora Arthuri** Farlow, in Bot. Gaz., vol. VIII, p. 315. [Syll., vol. VII, p. 248, No. 826.]

On leaves of *Onagrariae* April and May and December; most common in April.

On *Œnothera biennis* L.

737, June, 1885, Manhattan; (Exs. Fungi Gallici exsiccati No. 3373, June 10, 1886, Manhattan.)

On *Œnothera sinuata* L.

1563, April 15 and 20, 1888, Manhattan; 1545, April 21, 1888, Manhattan; 1566, May 14, 1888, Manhattan; (Exs. Kansas Fungi No. 12, May 14, 1888, Manhattan); 1547, oospores just forming (?), May 16, 1888, Manhattan; 1544, May, 1888, Manhattan; 1134, December 6, 1887, Manhattan.

On *Œnothera speciosa* Nutt.

1652, July 4, 1889, Manhattan.

On *Gaura parviflora* Dougl.

M. A. Carleton No. 92, May 22, 1888, Cloud county; 1546, May 26, 1888, Manhattan.

*According to Just. Bot. Jahresb., Jahrg. (1875) p. 179 and p. 251, where the following description is given:

Peronospora (Calothecae) Lini Schröter. Conidienträger sparrig dichotom verzweigt, Endäste pfriemlich. Conidien 18-20:13. Oosporen 22-26 Mik. Durchmesser. Epispor mit undeutlicher kleingenetzter Zeichnung.—Auf *Linum catharticum*.—Baden.

17. **Peronospora Oxybaphi** E. & K., in Journal of Mycology, vol. I, p. 2. [Syll., vol. VII, p. 248, No. 829.]

Conidia and oospores, on leaves of *Nyctagineae* May to July; most common in June.

On *Oxybaphus Nyctagineus* Sweet.

1761, May, 1886, Manhattan; 1508, May 23, 1886, Manhattan; 1614, May 23, 1889, Manhattan; 539, May 25, 1885, Manhattan; 1527, May 31, 1884, Zeandale, Riley county; 1562, June 13, 1888, Manhattan; 1619, oospores nearly mature, June 23 and 24, 1889, Manhattan; 1620, June 29, 1889, Manhattan; (Exs. N. A. F. No. 1418, June, 1884, Manhattan); 1651, July 4, 1889, Zeandale, Riley county.

The conidia of this species germinate by a lateral tube, which is short, thick, and rarely branched.

§ *Leiothecae* Schroet., in Cohn. Krypt. Flora, Schles. III., S. 243 (Parasiticae and Effusae DeBy.) [Syll., VII, p. 249.] Oospores sub-globose, epispore nearly smooth, sometimes folded. Mycelium mostly as in § *Calothecae.*

A Parasiticae wall of oogonium thick and rigid; oospore with a thin wall.

18. **Peronospora Corydalis** DeBary, in Ann. Sci. Nat., Ser. 4, t. XX, p. 107. Hedw. 1864, No. 9, p. 134. [Bot. Gaz., vol. VIII, p. 329; Syll., vol. VII, p. 329, No. 834.]

Conidia and oospores on leaves, stems, and inflorescence of *Fumariaceae*, February and April and May; most abundant in April.

On *Corydalis aurea* Willd., var. *occidentalis* Englm.

1582, on leaves, Feb. 3, 1889, Manhattan; 1575, on leaves, April 21, 1889, Manhattan; 1643, with mature oospores, on leaves and stems, April 22, 1888, Manhattan; (Exs. Kansas Fungi No. 13, with oospores, April, 1888, Manhattan); 1567, on leaves, stems and inflorescence, May 1, 1888, Manhattan; 1568, on leaves and stems, May 2, 1888, Manhattan; 517, on leaves, May 10, 1884, Manhattan; 1607, with mature oospores, on leaves and stems, May 14, 1889, Manhattan.

19. **Peronospora parasitica** (Pers.) Fries, Summa Veg. Scand., sec. pos., p. 493. Botrytis parasitica Pers. Obs. Mycol. I, p. 96, t. 5, fig. 6. [Bull. Bussey Inst., vol. I, p. 428; Bot. Gaz., vol. VIII, p. 313; Syll., vol. VII, p. 249, No. 830.]

Conidia and oospores, on leaves, stems and inflorescence of *Cruciferae*, April to July, and December; most common May.

On *Draba Caroliniana* Walt.

1561, on leaves, April 1, 1888, Manhattan; 1513, on leaves, April 5, 1888, Manhattan; 1554, on leaves, April 22, 1888, Manhattan; 1553, on leaves, stems, and capsules, April 25, 1888, Manhattan; 1543 (coll. Miss May Varney), on stems and leaves, May 3, 1889, Manhattan; 1577, on leaves, stems, and capsules, May 9, 1888, Manhattan; 1512*a*, on lower leaves, May 9, 1888, Manhattan (*Cystopis candidus* No. 1512 also occurs on the leaves of the same plants); 511, with immature oospores, on leaves, May 10, 1884, Manhattan; 1552, on leaves, stems, and capsules, May 13, 1888, Manhattan.

On *Sisymbrium canescens* Nutt.

1533*a*, on leaves, April 25, 1889, Manhattan (*Cystopus candidus* No. 1533 also occurs on same leaves); M. A. Carleton, No. 66, on leaves and stems, April 28, 1888, Cloud county; M. A. Carleton No. 80, on leaves, stems, and capsules, May 15, 1888, Wichita, Sedgwick county; M. A. Carleton No. 80*b*, on stems and inflorescence, May 22, 1888, Cloud county; 736, on leaves, stems, and capsules, June 5, 1884, Manhattan; 1579, on leaves, December 23, 1888, Manhattan.

On *Lepidium intermedium* Gr.

1535, on leaves, April 4, 1889, Manhattan; 1519, on leaves, April 5, 1888, Manhat-

tan (*Cystopus candidus* No. 1518 also occurs on the same leaves); 1531, on leaves, April 5, 1889, Manhattan; 1551, on leaves, April 14, 1889, St. George, Pottawatomie county; 1532, on leaves, April 17, 1889, Manhattan; 1611, on leaves and stems, May 29, 1889, Manhattan; E. Bartholomew No. 292, on leaves, stems, and capsules, May 29, 1889, Rooks county; 755, on leaves, June 1, 1885, Manhattan; 1612, on leaves and stems, June 3, 1889, Manhattan; 1658, on capsules and stems, July 6, 1889, Manhattan.

On *Lepidium Virginicum* L.

1560, on leaves and stems, May 13, 1888.

This very abundant species is quite sensitive to moisture when brought into a dry room; the conidiophores rapidly twist 1–4 times around, and the conidia fall off and collapse. No mature oospores have as yet been found.

20. **Peronospora Potentillae** De Bary, in Ann. Sci. Nat., ser. 4, t. XX, p. 120. [Bot. Gaz., vol. VIII, p. 314; Syll., vol. VII, p. 253, No. 842.]

On leaves of *Rosaceae* June, not common.

On *Geum album* Gmelin.

1637, June 20, 1889, Manhattan; 1895, July 14, 1889, Manhattan.

On *Potentilla Norvegica* L.

1571, June 17, 1888, Manhattan.

In Sacc. Syll. l. c., Berlese and De Toni put this species in the *effusae*, but according to Farlow, Bot. Gaz. l. c., it should be in the *parasitae*. It is much more common on *Potentilla* than on *Geum*.

21. **Peronospora Cynoglossi** Burrill, in litt.; N. A. F., No. 2206. (Name only.)

"Conidiophores slender, about 6 to 8 times dichotomously branched, widely spreading, mostly somewhat flexuose; conidia subglobose to elliptical, with an apical papilla, pale violet, 13–19 by 15–24μ; oogonia thick-walled, brown, 40–50μ; oospores with thick, smooth, light-brown walls, 25–30μ. Forming (on Cynoglossum) large, prominent, indefinite patches on the under surface of leaves, of which the upper surface is yellowish, becoming dark-brown."

(Occurs on *Cynoglossum officinale* L., Illinois.]

Var. (?) **Echinospermi** Swingle, nov. var. Not causing definite spots, usually occupying nearly all of the upper leaves and also the stems of the plants attacked, forming a rather dense, dusky coating on the affected leaves; conidiophores very abundant, arising singly, or more often in groups of from 2 to 5, through the stomata, hyaline, erect, 4–6 times sub-dichotomously branched, but almost always with one branch much stouter and more erect than the other, 240–414μ (mostly 275–400μ) long, 8–12μ (mostly 9–11μ) diam. at base, the unbranched basal portion 183–330μ (mostly 200–280μ) long, sub-cylindrical tapering gradually above, suddenly somewhat narrowed at the base, sometimes slightly inflated just above the narrowed base, branches short, stout, divergent, primary ramifications 2–5 (mostly 3–4) times branched with only a short unbranched portion, ultimate branches short (5–16μ), rather stout, acute, straight or slightly curved, usually in unequal pairs arising nearly at right-angles, the smaller one often curving back slightly, the penultimate and ante-penultimate branches often somewhat curved, sub-squarrose; conidia at first light-colored, oval or elliptical, when mature oval, sub-globose, or rarely globose or elliptical, dusky or dull-brownish, very obtuse at both ends, not papillate, 21–34x15–30μ, mostly 23–33x17–28μ, very soon deciduous, wall thin, smooth, contents homogeneous or sparingly and irregularly granular; oospores not seen.

On leaves and stems of *Borragineae* June.

On *Echinospermum Redowskii* Lehm., var. *cupulatum* Gr.

E. Bartholomew No. 320, June 5, 1889, Rooks county.

Peronospora Cynoglossi Burrill is readily distinguished from *P. Myosotidis* De Bary and *P. Asperuginis* Schroeter, both of which occur on *Borragineae*, by the oospores having a smooth epispore, and the wall of the oogonium being thick. *P. Myosotidis* De Bary is said to have the epispore marked with reticulate ridges, and *P. Asperuginis* Schroeter has a warty epispore. The conidiophores of *P. Cynoglossi* Burrill, in N. A. F., 2206, (on *Cynoglossum Virginicum*, Tunnel Hill, Ills., May, 1882, A. B. Seymour,) are more rigid; the conidia are more violet and more clearly papillate than *P. Myosotidis* De Bary, in F. Eu. No. 572, (in Myosotidis intermediae foliis, Friburgi Brisgavorum, Aprilli, 1862, leg. De Bary.)

The Kansas specimen on *Echinospernum*, collected by Mr. E. Bartholomew, I have called *P. Cynoglossi* Burrill, var. (?) *Echinospermi* Swingle. This form may very likely prove to be new, but as no oospores have been found, the question cannot now be settled. Dr. Burrill (in letter) thinks the Kansas specimens are a form of his *P. Cynoglossi*. The conidiophores are, however, much less branched and more rigid; the conidia much larger and not papillate, though not much different in color. It is to be hoped that oospores of this interesting form can be found. Measurements of this form are given below:

MEASUREMENTS OF *PERONOSPORA CYNOGLOSSI* BURRILL, VAR. (?) *ECHINOSPERMI* SWINGLE, ALL GIVEN IN μ's.

100 Conidia.*				25 Conidiophores.†				
				Total height.	*Length of unbranched basal portion.*	*Length of first branch.*	*Number of times branched.‡*	*Diameter at base.*
x15	25 x24	28 x22	30 x28	240	174	36	3–4	9
21 x15	25 x24	28 x23	31 x23	255	183	74	4–5	11½
21 x18	25 x24	28 x24	31 x23	261	195	66	4	8½
21 x20	25 x24	28 x24½	31 x23	270	210	54	4–5	10
21½x19	25 x25	28 x28	31 x23½	270	219	45	3–4	10
22 x18½	26 x20	28½x22½	31 x24	276	195	78	4	9
22 x22	26 x21	28½x25	31 x25	294	225	48	3–4	9
22 x22	26 x22½	29 x21½	31 x25	300	225	38	3–4	11
23 x18	26½x26	29 x22½	31 x26	306	252	69	2–5	11½
23 x20	27 x21	29 x23	31 x26	315	201	49	4–5	10½
23 x21	27 x22	29 x23	32 x23½	321	234	68	4	9½
23 x22½	27 x22½	29 x23	32 x24	324	240	78	4–5	10½
23 x23	27 x23	29 x24	32 x24	327	243	54	3–5	10
23½x18	27 x23	29 x24	32 x25	336	261	60	4	8½
24 x17	27 x23	29 x25	32 x25	348	270	60	3–5	10½
24 x17	27 x23	29 x25	32 x26	360	243	87	5–6	8
24 x20	27 x23	29 x25	32 x28	360	282	42	3–5	8½
24 x20	27 x23	29 x28	32½x23	366	270	75	4–5	12
24 x22	27 x24	30 x22	33 x26½	370	279	87	4–5	9
24 x23	27 x24	30 x23	33 x27	376	273	81	5–6	9
24 x23½	27 x24½	30 x23	33½x20	378	270	62	4–5	12
25 x19	27½x22½	30 x24	33½x30	390	310	76	5	9
25 x22	27½x22½	30 x25	34 x26	399	330	61	4–5	9½
25 x23	28 x18	30 x25½	34 x27	400	333	81	4–5	9½
25 x23½	28 x21½	30 x27	34 x27½	414	324	57	4–5	11½

*Measured from dried specimens moistened with dilute Potassium hydrate, with eyepiece micrometer having divisions of a value of 1μ. †Measured from same slide as the conidia, with an eyepiece micrometer having divisions of a value of 8μ. ‡When two figures are given in this column, the first gives the number of bifurcations found by counting up the first branch of the conidiophore, and the second the number obtained by counting up the main stem of the conidiophore to the extreme tip. Rarely the number of branches was the same in both, and then only one number is given.

b Effusae, wall of oogonium thin, wrinkled at maturity; exospore thin, usually, with a few irregular folds.

22. **Peronospora Trifoliorum** DeBary, in Ann. Sci. Nat., ser. 4, t. XX, p. 117. Hedw., 1864, No. 9, p. 137. [Bot. Gaz., vol. VIII, p. 329; Syll., VII, p. 252, No. 841.]

Conidia and oospores on leaves of *Leguminosae Papilionaceae* May and June.

On *Astragalus Canadensis* L.

1624, with abundant nearly mature oospores, May 18, 1886, Manhattan; 1625, June 20, 1884, Manhattan.

On *Astragalus lotiflorus* Hook.

1606, June 18, 1888, Manhattan; 1628, June 29, 1889, Manhattan; 937, June 30, 1887, Manhattan; 1787, August 18, 1889, Manhattan.

It may be that the form on *Astragalus lotiflorus* is not the same as on *A. Canadensis*, as no oospores were found on the former. The conidiophores and conidia, however, appear identical in both.

The oospores are quite different from those of *P. Viciae*, being almost smooth.

23. **Peronospora leptosperma** DeBary, in Ann. Sci. Nat., ser. 4, t. XX, p. 121. Hedw. 1864, No. 9, p. 139. [Bot. Gaz., vol. VIII, p. 331; Syll., vol. VII, p. 254, No. 847.]

Conidia and oospores on leaves of *Compositae Tubuliflorae* June and July.

On *Artemisia Ludoviciana* Nutt.

750, June 2, 1885, Manhattan; 1586, with a few nearly mature oospores, June 9, 1889, Manhattan; 1644, June 20, 1888, Manhattan; 1659, July 6, 1889, Manhattan.

24. **Peronospora alta** Fuckel. Fungi Rhenani Exs., No. 39; Symb. Myc., p. 71. [Bot. Gaz., vol. VIII, p. 328; Syll., vol. VII, p. 262, No. 879.]

Conidia and oospores on leaves of *Plantagineae* May and June.

On *Plantago major* L.

1578, May 14, 1887, Manhattan; 1523, May 22, 1886, Manhattan; 756, May 25, 1885. Manhattan; 1590, June 9, 1889, Manhattan; 1597, June 18, 1889, Manhattan; 1640, with nearly mature oospores, July 2, 1889, Manhattan.

25. **Peronospora candida** Fuckel, Fungi Rhenani Exs., No. 38 (1863); Symb. Myc., p. 71. PERONOSPORA ANAGALLIDIS Schroeter, in Rabenh. F. Eu., No. 1744 (1874); Hedwigia 1874, p. 45. PERONOSPORA ANDROSACES Niessl, in Rabenh. F. Eu., No. 1875 (1874). [Syll., vol. VII, p. 248 No. 828, p. 258 No. 860, p. 260 No. 869.]

Conidia and oospores on leaves of *Primulaceae* March to June; most common April and May.

On *Androsace occidentalis* Ph.

1572, on leaves of very young seedlings, March 24, 1889, Manhattan; 1649, on seedlings, March 31, 1889, Manhattan; 1664, with abundant nearly mature oospores, April 6, 1889, Manhattan; 1557, with oospores, April 16, 1888, Manhattan; 1555, with mature oospores, April 22, 1888, Manhattan; (Kansas Fungi No. 41), 1555; 1556, with very abundant mature oospores, June 22, 1888, Manhattan; 1573, on very small seedlings, December 24, 1888, Manhattan.

This abundant Kansas species seems to be the same as Fuckel's *P. Candida*, though I have no authentic specimens of it for comparison. It is, according to specimens in F. Eu., the same as *P. Anagallidis* Schroeter, of which Schroeter himself, in Just's Bot. Jahresb., 2 Jahrg. (1874), p. 209, says "wohl identisch mit *Per. cand.* Fuckel." It is the same as *P. candida* Fuckel in Roum. F. Sel. Exs., No. 4858, which is on *Anagallis coerulea*, and is evidently the same as *P. Anagallidis*, Schroeter. It also agrees fairly well with W. G. Smith's figure of *P. Candida* in The Gar-

dener's Chronicle, vol. XXV, new series p. 695, (fig. 125.) Our species is certainly Niessl's *P. Androsaces* according to F. Eu., No. 3380. I have examined *P. Anagallidis* Schroeter, in Rabenh. F. Eu., Nos. 1744 and 1745, and *P. Androsaces* Niessl., in Rabenh Wint. F. Eu., No. 3380, and think they are certainly the same species as *P. Androsaces* Niessl., in Kell. & Sw. Kansas Fungi, No. 41. The conidiophores of the Kansas specimen are slightly stouter and perhaps less branched, and the conidia are slightly larger than in the European specimens mentioned. The oospores are larger but of the same character. The following measurements are given to show the differences between the specimens examined. The conidia in all are oval, ovate, or more rarely, sub-globose, and are slightly dusky. The oospores of all have a very thick, irregular epispore and thin oogonia, which collapse, probably adding to the apparent thickness of the epispore. The endospore (?) is somewhat variable in thickness. In optical section the oospores appear angular in most cases, but are sometimes nearly smooth. It should, I think, be placed in the sub-section *Effusae*.

MEASUREMENTS.*

PERONOSPORA ANDROSACES, F. EU. 3380.†

Conidia.	*Oospores including epispore.*	*Oospores without the epispore.*	*Thickness of endospore.(?)*
20x14½	36x31	27x26	3
20x14½	36x33	26x25	3
20x15	37x36	27x26½	3
20x15	39x32	26x26	3
20x16	39x34	29x27	3
21x18	42x35	24x23	3
22x15½	42x38	27x26	3
22x16½	42x39	27x27	3
22x17	45x42	28x27	3
23x18	48x44	27x26	4

PERONOSPORA ANAGALLIDIS, F. EU. 1744‡ AND 1745.§

Conidia.	*Oospores with epispore.*	*Oospores without epispore.*	*Thickness of endospore.(?)*
18x14	33x31	25x24	2
20x15	36x33	26x26	2
20x16	36x34	21x21	1½
20x16	36x36	25x24	2½
21x16	38x34	23x22	2
21x16	39x38	29x26½	1½
21x16	40x37	24x23	2½
21x17	41x40	26x24	1½
22x17	42x35	23x21	1½
24x18	45x36	24x24	2

PERONOSPORA ANDROSACES, KAN. FUNG. 41.‖

Conidia.	*Oospores with epispore.*	*Oospores without epispore.*	*Thickness of endospore.(?)*
21x15	36x36	27x26	2
21x16	40x39	31x30	3
21x16	41x38	32x29	2½
22x18	41x39	33x30	2½
23x17	42x34	33x31	3
23x18	42x36	30x29	2½
24x16	42x37	27x27	3
24x21	42x38	30x29	2½
25x18	45x42	30x30	2
25x19	48x45	33x32	2½

PERONOSPRA CANDIDA, ROUMEGUERE FUNGI SELECTI, EXS. NO. 4858.¶

Conidia.	*Oospores including epispore.*	*Oospores without the epispore.*	*Thickness of endospore.(?)*
21x16	27x27	20 x19	2½
21x18	30x27	21½x20	1½
22x16½	32x30	21 x20	2
22x17	35x30	22 x21	2
23x17	35x32	24 x23	2½
23x17	36x32	29 x25	2½
23x17	36x33	23 x22	2
24x18½	38x36	25 x25	3½
25x17½	40x35	24 x23	2½
26x19	40x40	28 x28	3

*The conidia were in all cases mounted in very dilute KHO, and the oospores were mounted in water. The measurements were made with an eyepiece micrometer having divisions of a value of 3μ.

†"Suecia: prope Upsala. In foliis vivis Androsaces septentrionalis L., Mai, 1884, leg. C. J. Johanson."

‡[Oospores] "Auf Anaggallis coerulea Schrb. Auf einem Acker bei Rastatt, im October und November, 1873. Dr. Schröter."

§[Conidia] "An der untern Fläche lebender Blätter der Anagallis coerulea Schreb. Am Fusse der Weinberge hinter Unterissdorf bei Eisleben (Prov. Sachsen), August, 1873, leg. Johannes Kunze."

‖"On *Androsace occidentalis* Ph. Manhattan, Kansas, April 22, 1888."

¶"Sur les fenilles vivants de l' *Anagalis caerulea*. Dans un fossé desséché a Luchon (Haute-Garonne.) Ete 1888: *Ch. Fourcade*."

26. Peronospora grisea Unger, in Bot. Zeit. 1847, p. 315. BOTRYTIS GRISEA Unger, Die Examtheme der Pflanzen, S. 172 (1833). [Bot. Gaz., vol. VIII, p. 330; Syll., vol. VII, p. 255, No. 852.]

On leaves of *Scrophulariaceae* May; not common.

On *Veronica peregrina* L.

1549, May 13, 1888, Manhattan.

27. Peronospora Hedeomae Kell. & Sw. n. sp. Not causing definite spots, usually occupying nearly all of the lower leaves of the plant (or portion of the plant) attacked, forming a rather sparse, dusky layer on the under surface of the leaves, or more rarely on the stems or floral-bracts. Conidiophores hyaline, erect, 4–9, mostly 5–8, times dichotomously branched, but almost always with somewhat unequal branches, 160–465μ long, mostly 225–390μ; 6–12μ, mostly 8–11μ diameter at base. The unbranched basal portion 80–240μ, mostly about 100–200μ long, nearly cylindrical or tapering above, abruptly narrowed at the base, sometimes once or even twice inflated at a short distance from the base; branches long, rather stout, somewhat spreading, primary ramifications straight, unbranched for a considerable distance; ultimate branches short (6–12μ), thick, sub-acute, slightly curved or straight, usually in unequal pairs arising nearly at right angles to each other, never forcipate; the penultimate and ante-penultimate branches often curved so as to be nearly parallel for some distance. Conidia at first globose hyaline, but when mature fuscous, obovate or obovate-elliptical, sometimes elliptical or oval, usually more acute at the base; not papillate, 21–32x13–22μ, mostly 24–30x14–17μ, very early deciduous; wall very thin, smooth, contents homogeneous. Oospores globose or sub-oval, nearly hyaline or of a slightly yellowish color, 22½–31μ diam., mostly 25–29μ diam.; epispore rather thin (2½–3μ), smooth, often marked with rather short hyaline elevations, contents finely and evenly granular, sometimes with a large central gutta; oogonia large, usually somewhat oval, 30–50x27–36μ, mostly 33–45x30–35μ, not fitting the oospores closely.

Oospores and conidia on leaves and stems of *Labiateae* February and May to June; most abundant in May.

On *Hedeoma hispida* Ph.

1576, on leaves, February 3, 1889, Manhattan; 1548, on leaves and stems, with young oospores, May 4, 1888, Manhattan; 1610, on leaves and stems, with a few oospores, May 18, 1889, Manhattan; 1550, on leaves and stems, with mature oospores, May 20, 1888, Manhattan; 1671, on leaves and stems, with immature oospores, May 20, 1889, Manhattan; 1613, on leaves and stems, with mature oospores, May 22, 1889, Manhattan; 1595, on leaves, with mature oospores, June 6, 1889, Manhattan; 1636, on leaves and stems, with a few oospores, June 18, 1888, Manhattan.

This species is rather abundant on plants about Manhattan. The diseased plants are stunted and become yellowish-green, or sometimes reddish-green. The afflicted leaves finally turn black, and usually fall to the ground, leaving the stems bare. It differs from *Peronospora Lamii* and *P. Swinglei* in the shape and size of the conidia, and from *P. Swinglei* in having much smaller oospores. It differs from *P. Lophanthi* in having stouter conidiophores, without forcipate tips, in the shape and size of the conidia, and in color of the oospores. All attempts to induce germination of the conidia failed.

MEASUREMENTS, ALL GIVEN IN μ's.

100 Conidia.*				25 Conidiophores.†				
				Total height.	*Length of unbranched basal portion.*	*Length of first branch.*	*Number of times branched.‡*	*Diameter at base.*
21 x20	25 x15½	27 x14	29 x15	160	120	.....	.....	.....
22 x14	25 x15½	27 x15	29 x15½	210	80	100	6–7	.....
22 x14	25 x16	27 x15	29 x15½	210	105	75	4–5	6
22 x15	25 x16	27 x15	29 x17	225	110	.....	.....	.....
22 x15½	25 x17	27 x16	29 x17	225	150	.....	.....	.....
23 x15	25 x17	27 x16	29 x17	240	120	80	5–6	.....
23 x15	25 x17½	27 x16	29 x19	240	140	.....	.....	.....
23 x16	25½x14	27 x16	29 x20	245	150	105	5–6	8
23½x15	26 x15	27 x16½	29½x18	270	120	110	6–7	.....
23½x16	26 x15	27 x17	30 x15	282	165	95	4–5	11
24 x14	26 x15	27 x17	30 x15	290	130	.....	.....	.....
24 x14	26 x15	27 x17	30 x15	300	130	.....	.....	.....
24 x14½	26 x15	27½x15	30 x16	310	195	.....	.....	.....
24 x14½	26 x15½	27½x16½	30 x16	315	120	135	5–8	.....
24 x15	26 x16	28 x15	30 x17½	320	190	.....	.....	.....
24 x16	26 x16	28 x15	30 x18	330	159	110	5–7	12
24 x17	26 x17	28 x17½	30 x18	345	180	135	6–7	8
24½x14	26 x17	28 x19	30 x21	350	200	.....	.....	.....
25 x14	26½x15	28 x20	31 x14	375	190	.....	.....	.....
25 x14	26½x16	28 x20	31 x15	390	190	115	5–7	9
25 x14	26½x16	28½x16	31 x17	390	240	.....	.....	.....
25 x15	26½x16	28½x16½	32 x15	395	240	.....	.....	.....
25 x15	26½x16	28½x16½	32 x17	405	180	225	8–9	10
25 x15	26½x19	28½x17½	32 x19	435	240	.....	.....	.....
25 x15	27 x13	28½x19	32 x22	465	240	.....	.....	.....

* Measured from fresh specimens with an eyepiece micrometer having divisions of a value of 2½μ.
† Measured from same material and with the same micrometer as the Conidia. ‡ See foot-note on page 78.

25 Oospores.*

Diameter oospore.	*Thickness of wall.*	*Diameter oogonia.*	*Diameter oospore.*	*Thickness of wall.*	*Diameter oogonia.*
23x22½	2½	33x27	26½x25	2½	33x30
24x23	2½	42x33	26½x26½	3	35x34
25x25	2½	39x34	27 x26	2½	30x27
26x24	3	38x30	27 x26	3	40x35
26x25	2½	34x30	27 x26	2½	50x27
26x25	2½	35x33	27 x27	3	38x33
26x25	2½	36x34	28 x26½	2½	47x36
26x25	2½	37x33	29 x27	2½	36x32
26x25	2½	38x33	29 x27	2½	40x35
26x25	2½	38x34	30 x27	2½	50x35
26x25	2½	40x34	30 x30	2½	42x34
26x26	3	34x32	31 x30	2½	45x36
26x26	2½	40x35			

* Measured from fresh specimens with an eyepiece micrometer having divisions of a value of 2½μ.

28. **Peronospora Swinglei** E. & K., in Journal of Mycology, vol. III, p. 126.
Conidia and oospores on leaves and stems of *Labiateae* May and June.

On *Salvia Lanceolata* Willd.

1618, with nearly mature oospores, on leaves and stems, May 26, 1889, Manhattan;

1542, (Coll. F. A. Waugh,) on leaves, June 14, 1887, McPherson county; 1617, with mature oospores, on leaves and stems, June 10, 1889, Manhattan; 910, June, 1887, Manhattan; (Exs. N. A. F., No. 2203, June, 1887, Manhattan); E. Bartholomew No. 333, on leaves, June 17, 1889, Rooks county; 1653, June 29, 1889, Manhattan; 1771, on leaves, August 14, 1889, Manhattan; 1774, on leaves, August 28, 1889, Manhattan (*Cercospora Salviae* Kell. & Sw., often occurs on same leaves).

I have compared this species with a specimen of *Peronospora Lamii* (Al. Br.) De By., on Lamium purpureum from Kreiger, Fungi Saxonici No. 195, sent to me by Mr. J. B. Ellis. The conidia in this specimen were very like those of *P. Swinglei*, but were not quite so dark colored. The conidiophores were more slender and more flexuose above; the ultimate branches were somewhat longer and narrower. The oospores were very scarce, but the few seen were much like those of *P. Swinglei*, except in size, being much smaller (about 25–33μ).

The oospores of *P. Swinglei* are globose or slightly oval, at first hyaline, but when mature dusky brown, variable in size, 29–45μ diam., mostly 33–39μ diam., wall rather thin, 2–4μ, irregularly roughened, often with several low ridges, contents irregularly granular; oogonia somewhat larger that the oospore, thin-walled, hyaline, collapsing, about 40–55μ diam.

It may very possibly be that *P. Swinglei* is only a synonym of *P. Lamii*, but until I have examined more specimens I cannot decide.

29. **Peronospora Effusa** (Grev.) Rabenh. Klotz Herb. Viv. Myc., No. 1880. BOTRYTIS EPIPHYLLA (?) Pers. Myc. Eur., p. 36 (1822); SPOROTRICHUM FARINOSUM (?) Link, Spec. Pt. I, p. 6 (1824); BOTRYTIS EFFUSA Greville, Flora Edinensis, p. 468 (1824); BOTRYTIS FARINOSA Fries, Syst. Myc., vol. III, p. 404 (1829); PERONOSPORA FARINOSA Fries, Sum. Veg. Scand., p. 493 (1849); MONOSPORIUM CHENOPODII Schlect. Bot. Zeit. 1852, p. 619; PERONOSPORA CHENOPODII Casp. Bot. Zeit. 1854, p. 565. [Bull. Bussey Inst., vol. I, p. 426; Bot. Gaz., vol. VIII, p. 327; Syll., vol. VII, p. 256, No. 854.]

On leaves of *Chenopodiaceae* May and June.

On *Chenopodium album* L., var. *viride*.

762, May 23, 1885, Manhattan; 895, May 28, 1887, Manhattan; E. Bartholomew No. 299, May 30, 1889, Rooks county; 1588, June 9, 1889, Manhattan; M. A. Carleton No. 52, June 16, 1887, Cloud county.

Mr. Bartholomew states that although it is more common on the variety *viride* of *Chenopodium album*, he has also seen it on the species, but did not collect any specimens.

Fries gives *Botrytis epiphylla* Pers. as a synonym of his *B. farinosa*, in Syst. Myc., vol. III, both on page 404 and in the index, on the strength of specimens, though, as he states, Persoon's description is faulty. Streinz, in Nomenclator Fungorum, p. 161, also gives *Botrytis epiphylla* Pers. as a synonym of *B. farinosa*, and does not indicate any doubt. Saccardo, in Syll., vol. IV, p. 118, says, after the description of *Botrytis epiphylla* Pers.: "An *Peronospora effusa* (Grev.) De Bary ?" There can be no doubt that *Botrytis farinosa* Fr. is the same as *Botrytis effusa* Grev., but if Persoon's name is used, it has priority of Greville's name by two years. The only fault in Persoon's description is that he says, "stipite simplice brevissimo," which could not be true unless he had stunted or broken specimens, which might have been the case.

30. **Peronospora Rumicis** Corda, Icones Fung. I, p. 20, t. 5, fig. 273. PERONOSPORA EFFUSA (Grev.) Rabenh., var. POLYGONI Thüm. Fungi Austriaci Exs. Nos. 942 and 836. PERONOSPORA POLYGONI Thüm., in Verhandlungen der K. K. Zoolog.-Bot. Gesell. in Wien, 1874. [Bot. Gaz., vol. VIII, p. 327; Syll., vol. VII, p. 257, No. 854.]

On leaves of *Polygonaceae*, July. Rare.

On *Polygonum dumetorum* L., var. *scandens* Gr.

1639, July 1, 1889, Manhattan; 1654, July 4, 1889, Zeandale, Riley county.

A comparison of *Peronospora Rumicis* Corda in Rabenhorst Fungi Europaei, Nos. 988 and 2677, with *Peronospora Polygoni* Thüm. in Ellis's North Am. Fungi, No. 1409, and with specimens from Iowa and Kansas, showed that there were no constant differences between Corda's *P. Rumicis* and Thümen's *P. Polygoni*. Specimens on *Polygonum aviculare*, collected by Mr. A. S. Hitchcock, at Iowa City, Iowa, were almost exactly like Fungi Europaei, No. 988, on *Rumex acetosella* from Germany. In Syll., vol. VII, p. 262, and Schroeter's Krypt. Flora Schles. III, p. 252, *Peronospora Rumicis* Corda is said to occur on species of *Polygonum*.

31. **Peronospora Euphorbiae** Fuckel, Fungi Rhenani Exs. No. 40; Symb. Myc., p. 71. [Bot. Gaz., vol. VIII, p. 330; Syll., vol. VII, p. 257, No. 855.]

Conidia and oospores on leaves, stems and inflorescences of *Euphorbiaceae*, August and September.

On *Euphorbia glyptosperma* Englm.

1873, with abundant mature oospores, on leaves, stems, and inflorescences, August 14, 1889, Manhattan; 1762, with nearly mature oospores, on leaves, stems, and inflorescences, August 18, 1889, Manhattan; 1667, with immature oospores, on leaves, stems, and inflorescences, August 19, 1889, St. George, Pottawatomie county.

On *Euphorbia hypericifolia* L.

1787, on leaves, August 11, 1889, Manhattan; 1791, on leaves, stems, and inflorescences, September 3, 1889, Manhattan.

On *Euphorbia maculata* L.

1770, on leaves, August 10, 1889, Manhattan; 1794, with nearly mature oospores, on leaves, stems, and inflorescences, August 18, 1889, Manhattan; 1786, with abundant immature oospores, on leaves, stems, and inflorescences, August 19, 1889, St. George, Pottawatomie county; 1645, on leaves, stems, and inflorescences, September 9, 1887, Manhattan.

On *Euphorbia serpens* HBK.

1869, on leaves, stems, and inflorescences, August 14, 1889, Manhattan; 1795, with immature oospores, on leaves, stems, and inflorescences, September 1, 1889, Manhattan; 1870, with abundant nearly mature oospores, but no conidia, on leaves, stems, and inflorescences, September 16, 1889, Manhattan.

This species is very abundant at Manhattan, and causes a distortion of the ends of the branches, which become of a yellowish color. This is, perhaps, our latest species to appear, as it has never been found until August.

c. Species of uncertain section, whose oospores are unknown.

32. **Peronospora Sordida** Berkeley, in Ann. Mag. Nat. Hist., 3d ser., vol. VII, p. 449. [Bot. Gaz., vol. VIII, p. 333; Syll., vol. VII, p. 262, No. 881.]

On leaves of *Scrophulariaceae*, May to September, and December.

On *Scrophularia nodosa* L.

562, May 15, 1885, Manhattan; 1663, June 25, 1884, Manhattan; 1642, July 2, 1889, Manhattan; 1789, August 11, 1889, Manhattan; 1799, September 1, 1889, Manhattan; 1901, September 26, 1889, Manhattan; 1608, December 1, 1888, Manhattan.

INDEX TO HOST PLANTS.

[Obs. Br. indicates *Bremia*, Cy. *Cystopus*, Per. *Peronospora*, Pl. *Plasmopara*, Scl. *Sclerospora*. The reference after each abbreviation of the generic name is to the serial number of the species in the list.]

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* VARIETIES.—These are arranged alphabetically, and give in parenthesis the damage on a scale of

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[Obs. The numbers and abbreviations indicate the same as in the preceding index. Bentham & Hooker's "Genera Plantarum" is followed for the sequence and names of the families.]

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Amber Queen (10) hybr.
Amminia (10) hybr.
August Giant (5) hybr.
Beauty (15) hybr.
Black Eagle (1) hybr.
Brant (1) hybr.
Brighton (25) hybr.
Catawba (20) Labr.
Centennial (20) hybr.
Concord (20) Labr.
Creveling (30) Labr.
Croton (20) hybr.
Delaware (40) hybr.
Diana (30) Labr.
Downing (40) hybr.
Dracut Amber (8) Labr.
Early Victor (8) Labr.
Eaton's Seedling (20) Labr.
El Dorado (1) hybr.
Etta (25) hybr.
Eumelan (15) æst.
Eva (8) hybr.
Faith (10) hybr.
Grein's Golden (15) hybr.
Hartford Prolific (2) Labr.
Highland (25) hybr.
Humboldt (15) hybr.
Iona (10) Labr.
Iowa Excelsior (20) hybr.
Isabella (10) Labr.
Ives (1) Labr.
Jefferson (20) hybr.
Jessica (8) doubt.
Lady (20) Labr.
Lenoir (10) æst.
Lindly (50) doubt.
Marion (20) hybr.
Martha (5) Labr.
Mason's Seedling (30) Labr.
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Maxatawney (10) Labr.
Merrimac (1) hybr.
Miles (10) Labr.
Moore's Diamond (25) doubt.
Montefiore (15) hybr.
Missouri Reisling (10) hybr.
Moyer (15) hybr.
Naomi (40) hybr.
Noah (5) hybr.
Norfolk (8) Labr.
Niagara (15) hybr.
Pearl (8) hybr.
Perkins (10) Labr.
Pocklington (10) Labr.
Potter's Sweet (15) hybr.
Prentiss (15) Labr.
Rebecca (20) Labr.
Rochester (40) doubt.
Salem (5) hybr.
Triumph (10) hybr.
Venango (5) Labr.
Vergennes (15) Labr.
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AN ARTIFICIAL KEY TO THE KANSAS GRASSES.

BY W. A. KELLERMAN, PH. D.,
State Agricultural College.

[Descriptions of the species are given under corresponding numbers in "The Native Grasses of Kansas," published in the Report of the State Board of Agriculture for the Quarter ending March 31, 1889.]

Spikelets sessile on opposite sides of a jointed, or channeled rachis, forming a simple spike (1).
Spikelets not as above (5).

1. Spikelets single at each joint of the rachis (2).
1. Spikelets 2 or more at each joint of the rachis (3).

2. Spikelets one-flowered, partly immersed in the triangular rachis.....**30** SCHEDONNARDUS.
2. Spikelets many-flowered, placed edgewise on the rachis.....**52** LOLIUM.
2. Spikelets several-flowered, placed flatwise on the rachis.....**53** AGROPYRUM.

3. Outer glumes anterior, forming a sort of involucre (4).
3. Outer glumes none or 1-2 awn-like rudiments.....**56** ASPRELLA.

4. All the spikelets perfect and similar.....**55** ELYMUS.
4. Central spikelet of each cluster perfect and sessile, the two lateral short-stalked and sterile.....**54** HORDEUM.

5. Spikelets in a coriaceous, spiny involucre, or bur..... **7** CENCHRUS.
5. Spikelets capitate; small grasses, creeping or stoloniferous (6).
5. Spikelets not as above (7).

6. Fls. dioecious, staminate fls. in conspicuous spikes; perennial.....34 BUCHLOE.
6. Fls. perfect (or upper imperfect); an annual creeping grass.....35 MUNROA.

7. Fls. monoecious in jointed spikes; upper spikelets staminate sessile; lower spikelets pistillate, and imbedded in the thickened cartilaginous rachis... 1 TRIPSACUM.
7. Flowers not as above (8).

8. Fls. crowded in a dense cylindrical spike (9).
8. Fls. in one-sided spikes or branches of the panicle (19).
8. Fls. in simple, racemose, spicate, contracted or more or less spreading panicles (34).

9. Spike oval, or at most oblong; very dense.....10 PHALARIS.
9. Spike cylindrical (10).

10. Spike very dense and cylindrical (11).
10. Spike less dense or very loose (12).

11. Flowering glume with a slender dorsal awn.....18 ALOPECURUS.
11. Flowering glume destitute of an awn.....17 PHLEUM.

12. Several bristles below the articulation of the spikelets.....6 SETARIA.
12. No bristles below the articulation of the spikelets (13).

13. Outer glumes long-awned, flowering glumes generally awned.....20 POLYPOGON.
13. Outer glumes often bristle-pointed, flowering glumes triple-awned.....12 ARISTIDA.
13. Outer glumes not long-awned, flowering glumes not triple-awned (14).

14. Glumes blunt, acute, or pointed, but not awned (15).
14. Some of the glumes awned (17).

15. Spikelets 3-5-flowered, compressed.....42 KOELERIA.
15. Spikelets 1-flowered, occasionally a rudiment above (16).

16. Lower outer glume longer than the flowering glume.....22 AGROSTIS.
16. Outer glumes small or nearly as large as the flowering glume.....15 MUHLENBERGIA.

17. Spikelets 1-flowered, 6 glumes present, no true palet.....11 ANTHOXANTHUM.
17. Spikelets 1-flowered, but only 4 glumes present (18).

18. Lower outer glume larger than the flowering glume.....22 AGROSTIS.
18. Outer glumes small or nearly as large as the flowering glume.....15 MUHLENBERGIA.

19. Flowers dioecious, the pistillate in short capitate spikes.....34 BUCHLOE.
19. Flowers not as above (20).

20. Glumes (or palets) only two, chartaceous, strongly compressed.....9 LEERSIA.
20. Glumes (including palets) more than two (21).

21. Spikelets with one perfect flower and two empty, hairy, nearly equal outer glumes, with a cup-like or annular swelling of the pedicel just below the spikelet.....4 ERIOCHLOA.
21. Spikelets, etc., not as above (22).

22. Spikelets with one or more flowers, but only one perfect (23).
22. Spikelets with two or more perfect flowers (31).

23. Flowers in indistinctly one-sided spikes or bunches (24).
23. Flowers in strictly one-sided spikes or clusters (27).

24. Spikelets solitary at each joint of the slender triangular rachis, and partly immersed in an excavation.....30 SCHEDONNARDUS.
24. Spikelets not as above (25).

25. Stamen 1, palet only 1-nerved, nearly as long as its glume.....21 CINNA.
25. Stamens 2 or 3, palet2-keeled or 2-nerved (26).

26. Spikelets several-flowered, flowering glumes awnless.....33 LEPTOCHLOA.
26. Spikelets with 1 (or rarely 2) perfect flower and a bristle-like rudiment or awn-like pedicel.....29 GYMNOPOGON.

27. Spikelets sessile and remotely alternate on long and filiform branches of the panicle, flowers awned.....29 GYMNOPOGON.
27. Spikelets not as above, flowers awned or awnless (28).

28. Flowers awned (29).
28. Flowers awnless (30).

29. Spikes digitate or fasciculate at the summit of the culm.....28 CHLORIS.
29. Spikes numerous in a racemose panicle, or one terminal; spikelets densely crowded.....31 BOUTELOUA.

30. Spikes solitary or paniculate, spreading or deflexed, flattened (80).
30. Spikes triangular, racemose; spikelets *much* flattened....27 SPARTINA.
30. Spikes racemed, slender, usually numerous....33 LEPTOCHLOA.

31. Spikelets in dense fascicles or glomerate clusters indistinctly or not at all one-sided....47 DACTYLIS.
31. Spikelets not as above (32).

32. Spikes digitate at the summit of the culm, (sometimes scattering ones lower down); spikelets crowded....32 ELEUSINE.
32. Spikes, etc., not as above (33).

33. Spikelets with 1 (rarely 2) perfect flower and a bristle-like rudiment or awn-like pedicel....29 GYMNOPOGON.
33. Spikelets not as above, many-flowered, narrow....39 DIPLACHNE.

34. Spikelets sessile and remotely alternate on long and filiform branches of the panicle, one (or 2) flowered and a bristle-like rudiment or an awn-like pedicel....29 GYMNOPOGON.
34. Spikelets not as above (35).

35. Spikelets two-flowered (36).
35. Spikelets three to many-flowered (41).
35. Spikelets one-flowered, at least but one flower perfect (52).

36. Swamp grasses, very tall (7–12 ft.), with long and broad leaves....36 PHRAGMITES.
36. Not as above (37).

37. Second glume broadly obovate, not keeled....41 EATONIA.
37. Second glume not broadly obovate (38).

38. Flowering glumes with a fine dorsal awn below the middle....25 DESCHAMPSIA.
38. Flowering glumes destitute of awns (39).

39. Palet about equaling the flowering glume (40).
39. Palet shorter than its glume, ciliate on keel and apex....43 MELICA.

40. Spikelets usually more than 2-flowered, somewhat compressed....48 POA.
40. Spikelets usually one (rarely 2) flowered, not compressed....19 SPOROBOLUS.

41. Flowering glumes with a flattish, twisted, bent awn....26 DANTHONIA.
41. Awns absent or not as above (42).

42. Swamp grasses, very tall (7–12 ft.), with long and broad leaves....36 PHRAGMITES.
42. Not as above (43).

43. Spikelets in dense fascicles or glomerate clusters at the ends of the short branches of a close, short panicle....46 DACTYLIS.
43. Spikelets not as above (44).

44. Drooping flat spikelets an inch long and nearly half an inch wide....45 UNIOLA.
44. Spikelets not as above (45).

45. Flowering glumes 3 to 5 or many-nerved, more or less involute, the upper two or more empty or imperfect....43 MELICA.
45. Flowering glumes 5 to many-nerved, the upper one empty (46).
45. Flowering glumes 3 or one-nerved (47).

46. Flowering glumes rigidly membranaceous or subcoriaceous, faintly many-nerved, much compressed and keeled; spikelets many-flowered dioecious, 46 DISTICHLIS.
46. Flowering glumes 5–7-nerved, often with a few loose or webby hairs at base; spikelets somewhat compressed, usually 2–5-flowered....48 POA.
46. Flowering glumes obtuse, more or less denticulate at the apex, not keeled but rounded on the back, 5 to 9-nerved, the nerves separate and all vanishing before reaching the apex; spikelets terete or flattish....49 GLYCERIA.
46. Flowering glumes narrow, rounded on the back, more or less distinctly 3–5-nerved, acute or tapering into a straight awn....50 FESTUCA.
46. Flowering glumes rounded on the back or compressed and keeled, 5–9-nerved, acute or awned from below the mostly 2-cleft apex, grain adhering to the palet....51 BROMUS.

47. Second glume broadly obovate, shorter than the spikelet, not keeled, 3-nerved....41 EATONIA.
47. Second glume not broadly obovate (48).

48. Flowering glumes not keeled but rounded on the back, (at least below,) the palet broad (49).
48. Flowering glumes keeled (50).

49. Flowering glumes broadly ovate, rigidly coriaceous, the 3 nerves prominent and uniting to form a pointed tip, stamens 2.....44 DIARRHENA.
49. Flowering glumes not as above, either cuspidate, or 3-toothed or erose; stamens 3.....37 TRIODIA.

50. Spikelets narrow, sessile or nearly so, more or less distant on the long branches of the panicle, usually in 2 rows.....39 DIPLACHNE.
50. Spikelets 3–5-flowered, numerous in a dense spike-like cylindrical or interrupted panicle.....42 KOELERIA.
50. Spikelets pedicillate or sessile, but not as above (51).

51. Spikelets usually many-flowered, palet shorter than the glume, often persisting after the grain and glume have fallen away.....40 ERAGROSTIS.
51. Spikelets ovate, 3–5-flowered; palet longer than its glume, of nearly the same texture, bidentate, folded lengthwise in the middle and with the two keels folded in the opposite direction.....38 REDFIELDIA.

52. Culm with a single, uniform, cylindrical (or oval) spike or spike-like panicle (53).
52. Not as above (58).

53. Bristles below the spikelets (54).
53. No bristles present (55).

54. One or sometimes 2 small scales or bristles below the flower, spike ovoid.....10 PHALARIS.
54. Conspicuous bristles below the spikelets, spike cylindrical..... 6 SETARIA.

55. Flowering glume terminating in a trifid awn, or apparently 3-awned.....12 ARISTIDA.
55. Awns absent or not trifid (56).

56. Outer glumes long-awned from the apex.....20 POLYPOGON.
56. Outer glumes acute (57).

57. Glumes 4, none of them awned.....10 PHALARIS.
57. Glumes 6, second pair awned on the back.....11 ANTHOXANTHUM.

58. Outer glumes hairy, a peculiar cup-like or annular swelling of the pedicel just below the spikelet..... 4 ERIOCHLOA.
58. Not as above (59).

59. Swamp grasses, 7 to 12 feet tall, leaves very broad and long, panicle large terminal.....36 PHRAGMITES.
59. Not as above (60).

60. Awns trifid, or apparently 3 awns.....12 ARISTIDA.
60. Awns absent or not trifid (61).

61. Glumes (including palet) only 2; flowers monoecious..... 8 ZIZANIA.
61. Glumes (including palet) 6, second pair awned on the back.....11 ANTHOXANTHUM.
61. Glumes (including palet), the normal number (62).

62. Flowering glume coriaceous, rigid, involute with a simple twisted awn from the apex.....13 STIPA.
62. Flowering glume not as above (63).

63. Spikelets solitary at each joint of the slender triangular rachis of the paniculate spikes, and partly immersed in an excavation.....30 SCHEDONNARDUS.
63. Spikelets not as above (64).

64. Flowering glume hardened, often with a sharp-pointed and bearded pedicel at the base, awn twisted.....13 STIPA.
64. Flowering glume awned, but not as above (65).
64. Flowering glume not awned (73).

65. Spikelets sessile and remotely alternate, on long and filiform branches of the panicle, each with one, or rarely 2 perfect flowers, and with a bristle-like rudiment or an awn-like pedicel.....29 GYMNOPOGON.
65. Not as above (66).

66. Palet ciliate on the apex and keels, lateral nerves of the outer glumes vanishing within the scarious margin.....43 MELICA.
66. Palet rigid, broad, stamens 2, grain very large, larger than the flower; flowering glume pointed, but not really awned.....44 DIARRHENA.
66. Palet only one-nerved, stamen one, flowering glume awned near the apex...21 CINNA.
66. Palet not as above (67).

67. Flowers in simple or paniculate spikes, spikelets in pairs (one pedicillate) in the alternate notches of the rachis..... 2 ANDROPOGON.
67. Flowers not as above (69).

68. Spikelets in a simple racemose panicle, outer glumes minute, the upper about half a line long, palet hyaline and bifid at the apex..... 16 BRACHYELYTRUM.
68. Not as above (69).

69. Spikelets one-flowered, with a bristle-like or pedicillate hairy rudiment opposite the palet.....23 CALAMAGROSTIS.
69. Not as above (70).

70. Palet about as long as the flowering glume, and of the same texture.....15 MUHLENBERGIA.
70. Palet shorter than the flowering glume, or wanting (71).

71. Inflorescence in simple or paniculate spikes..... 2 ANDROPOGON.
71. Inflorescence paniculate (72).

72. Spikelets one-flowered, flowering glume awned on the back.....22 AGROSTIS.
72. Fertile spikelets one-flowered, sessile between two pedicillate sterile spikelets at the end of the slender branches of the panicle..... 2 ANDROPOGON.

73. Palet ciliate on the keel and apex, the lateral nerves of the outer glumes vanishing within the scarious margin.....43 MELICA.
73. Palet (and glumes) sparingly ciliate, hyaline, glumes with hyaline margins..... 2 ANDROPOGON.
73. Palet not as above (74).

74. Lower glume narrow-keeled, the second broadly obovate not keeled, 3-nerved, scarious-margined, flowering glumes oblong.....41 EATONIA.
74. Lower glume narrow, the second ovate, 5-nerved, keeled, flowering glumes broadly ovate, rigidly coriaceous.....44 DIARRHENA.
74. Not as either of the above (75.)

75. Flowers with a tuft of hairs at base (76).
75. Flowers destitute of a tuft of hairs (77).

76. Outer glumes nearly equal, rigid, 5-nerved, palet sulcate between the keels, 24 AMMOPHILA.
76. Outer glumes unequal, thinly membranaceous, palet 2-toothed.....23 CALAMAGROSTIS.

77. The perfect flower of the spikelet closed coriaceous or cartilaginous, stigmas usually purple..... 5 PANICUM.
77. Flower not as above (78).

78. Palet shorter than the flowering glume, frequently reduced to a small scale or wanting, outer glumes nearly equal or the lower rather longer.....22 AGROSTIS.
78. Palet about equaling the flowering glume, and of the same texture (79).

79. Flowering glume with a very short usually hairy callus, mucronate or awned, outer glumes from small or minute to nearly as large as the flowering glume, persistent, sometimes bristle-pointed.....15 MUHLENBERGIA.
79. Flowering glume destitute of a callus and unawned, outer glumes unequal, the lower one shorter, often acute, but really unawned.....19 SOROBOLUS.

80. Spikelets with one terminal perfect flower, the flowering glume more or less concave, becoming indurated, embracing the short palet, which is of the same texture..... 3 PASPALUM.
80. Spikelets with one perfect terminal flower, and usually a second (staminate or rudimentary) one below, glume of the terminal flower with its palet usually of a coriaceous texture..... 5 PANICUM.

1. TRIPSACUM L.

a. Spikes 4 to 8 inches long, at the summit and from upper sheaths..... 1

1.* *Tripsacum dactyloides* L.; Gama grass, Sesame grass.

2. ANDROPOGON L.

a. Panicle terminal and narrowly oblong (6-12 inches), yellowish or russet..... 9
a. Peduncle solitary, bearing a single spike..... 2
a. Spikes more numerous (*b*).
b. Culms bushy — branched at summit, spikes in thick, leafy clusters..... 4
b. Culms, etc., not as above (*c*).

* The species, with corresponding numbers, also descriptions, are given in "The Native Grasses of Kansas," in the Quarterly Report of the State Board of Agriculture, March, 1889.

c. Spikes 1 in. long, 2 or 3 together, in distant clusters, shorter than bracts 8
c. Spikes 1–2 inches long, slender, single and scattered, not as above 3
c. Spikes in pairs or clustered, or digitate (*d*).
d. Stamens 3, spikes digitate, hairs short and sparse 5
d. Like the above, but glaucous, villous with white or yellowish hairs 6
d. Fert. fl. with 1 stamen, spikes in pairs or fours, hairs long, white, dense 7

2. *Andropogon tener* Kunth.; Broom grass.
3. *A. scoparius* Mx.; Little Blue Stem, Wood grass, Broom grass.
4. *A. macrourus* Mx.; Heavy-topped Broom grass.
5. *A. provincialis* Lam.; Big Blue Stem, Broom grass.
6. *A. Hallii* Hack.; Hall's Broom grass.
7. *A. saccharoides* Swz.; Broom grass.
8. *A. Virginicus* L.; Broom grass.
9. *A. nutans* L.; Wood grass, Indian grass, Bushy Blue Stem.

3. Paspalum L.

a. Spikelets two-rowed (*b*).
a. Spikelets four-rowed, dense, orbicular, and obtuse 10
b. Spikes with a thin and keeled rachis with incurved margins 11
b. Spikes not as above (*c*).
c. Spikelets ¼ line wide, narrowly two-rowed 12
c. Spikelets over one line wide, broadly two-rowed 13

10. *Paspalum virgatum* L.
11. *P. fluitans* Kunth.; Marsh Paspalum.
12. *P. setaceum* Mx.; slender Paspalum.
13. *P. lœve* Mx.; smooth Paspalum.

4. Eriochloa H. B. K.

a. Stem erect, the nodes and stem above pubescent 14

14. *Eriochloa punctata* Hamilt.

5. Panicum L.

a. Spikes mostly digitate, flat, one-sided (*b*).
a. Spikelets imbricate-spiked, panicle simple or comp., often with stiff hairs (*c*).
a. Spikelets scattered, in panicles (*d*).
b. Spikelets ovoid, about 1 line long, second glume equaling the flower 15
b. Spikelets oblong, about 1½ lines long, second glume ½ length of flower 16
c. Panicle dense, spikes 1–3 inches long, more or less compound 31
c. Panicle slender, its branches simple, the perfect flower less pointed; resembles small and smooth forms of the last 32
d. Panicle small, narrow, branches few, erect (*e*).
d. Panicle small but diffuse, oval or oblong (*f*).
d. Panicle larger, oval or oblong (*g*).
d. Panicle effuse, branches capillary and much subdivided (*j*).
d. Panicle ample and diffuse; tall grasses (*l*).
e. Lvs. 5–10 lines wide, strongly 9–11 nerved, margin scabrous 26
e. Lvs. erect, narrowly linear, sheaths usually pubescent 30
f. Spikelets ½–1 line long: plant very variable 29
f. Spikelets 1½–1¾ lines long; also variable 28
g. Velvety-downy all over, except a narrow ring below each node 27
g. Smooth or hairy, but not as above (*h*).
h. Lvs. broadly lanceolate from a cordate base, 3–4 in. long, ¾–1½ in. wide 23
h. Lvs. 4–8 inches long, lanceolate or oblong-lanceolate (*i*).
i. Spikelets oval, five-eighths of a line long, culms stout, smooth 25
i. Spikelets oblong-ovate to obovate, 1½ lines long, culms rigid, leafy to top 24
j. Panicle ½–⅔ length of culm, culm erect or decumbent below (*k*).
j. Panicles terminal and lateral, culms decumbent, stout, sheaths flattened 19
k. Panicles ½–⅔ length of plant, much branched, sheaths very hairy 20
k. Panicle ⅓–½ length of plant, very effuse, capillary branches long, sparingly divided 21
l. Panicles terminal and lateral (*m*).
l. Panicles terminal only, 6–18 in. long, culm 3–6 ft. high 22

m. Culms erect, 2–4 ft. high; root perennial (*n*).
m. Culms geniculate at the decumbent or procumbent base; annual 19
n. Culms stout, much branched above, spikelets racemose, crowded, mostly one-sided 18
n. Culms less stout, apex of spikelets a little curved 17

15. *Panicum glabrum* Gaud.; smooth Panic grass.
16. *P. sanguinale* L.; Crab grass; Finger grass.
17. *P. anceps* Mx.; two-edged Panic grass.
18. *P. agrostoides* Spreng.; red-top Panic grass.
19. *P. proliferum* Lam.; branching Panic grass.
20. *P. capillare* L.; Old Witch grass; hair-stalked Panic grass.
21. *P. autumnale* Bosc.; Autumn Panic grass.
22. *P. virgatum* L.; Switch grass.
23. *P. latifolium* L.; Broad-leaved Panic grass.
24. *P. clandestinum* L.; Panic grass.
25. *P. microcarpon* Muhl.; Panic grass.
26. *P. xanthophysum* Gr.; Panic grass.
27. *P. viscidum* Ell.; Panic grass.
28. *P. scoparium* Lam.; Panic grass.
29. *P. dichotomum* L.; Panic grass.
30. *P. depauperatum* Muhl.; Panic grass.
31. *P. Crus-galli* L.; Barnyard grass.
32. *P. colonum* L.; Panic grass.

6. Setaria Beauv.

a. Bristles in clusters, roughened or barbed upwards (*b*).
a. Bristles single or in pairs, roughened or barbed downwards 33
b. Spike tawny yellow, bristles 6–11, perfect flower wrinkled 34
b. Spike green, bristles few, perfect flower less distinctly wrinkled 35

33. *Setaria verticillata* Beauv.; Fox-tail grass.
34. *S. glauca* Beauv.; Yellow Fox-tail.
35. *S. viridis* Beauv.; Green Fox-tail, Pigeon grass, Bottle grass.

7. Cenchrus L.

a. Stems branched and ascending, the fruit a pestiferous bur 36

36. *Cenchrus tribuloides* L.; Sand-bur, Hedgehog grass.

8. Zizania L.

a. Upper branches of panicle erect pistillate, lower spreading staminate 37

37. *Zizania aquatica* L.; Wild Rice, Indian Rice, Water Oats.

9. Leersia Swartz.

a. Spikelets narrowly oblong, somewhat crowded (*b*).
a. Spikelets broadly oval, imbricately covering each other 40
b. Panicle simple, spikelets 1½ lines long, stamens two 38
b. Panicle diffusely branched, spikelets 2½–3 lines long, stamens three 39

38. *Leersia Virginica* Willd.; White grass.
39. *L. oryzoides* Swz.; Cut grass, White grass, False Rice.
40. *L. lenticularis* Mx.; Fly-catch grass.

10. Phalaris L.

a. Panicle dense spike-like, oval or oblong (*b*).
a. Panicle branched, the clusters open in anthesis 43
b. Spike oval, culm one to two feet high 41
b. Spike oblong, 1–2 (or more) inches long, culm taller 42

41. *Phalaris Canariensis* L.; Canary grass.

42. *P. intermedia* Bosc.; Southern Reed-Canary grass, California Timothy.
43. *P. arundinacea* L.; Reed-Canary grass.

11. Anthoxanthum L.

a. Culms slender; very sweet-scented in drying..... 44

44. *Anthoxanthum odoratum* L.; Sweet Vernal grass.

12. Aristida L.

a. Awns separate to the base, not *jointed* with the glume (*b*).
a. Awns jointed with the glume below their junction..... 50
b. Awns *very* unequal, the elongated middle one bent (*c*).
b. Awns all diverging and alike, or lateral ones but little shorter (*e*).
c. Outer glumes 9–10 lines long, 3–5-nerved..... 45
c. Outer glumes 3–4 lines long, carinately 1-nerved (*d*).
d. Lateral awns 6–7 lines long, middle one 10–12 lines..... 47
d. Awns much shorter: culms much branched throughout..... 46
e. Panicle spiked, 10–18 inches long (*f*).
e. Panicle loosely few-flowered, at most 6 inches long (*g*).
f. Awns much longer than the flower, middle one about one inch..... 52
f. Awns about the length of the flower, 6 lines or shorter..... 48
g. Stems simple, 6–15 inches high, panicle 3-6 inches long, awns long or short, outer glumes purplish..... 49
g. Stems tufted, low, awns capillary exceeding the slender flower, 1½–3 inches long..... 51

45. *Aristida ramosissima* Englm.; Triple-awned grass.
46. *A. dichotoma* Mx.; Beard grass, Three-awned grass.
47. *A. gracilis* Ell.; Beard grass, Three-awned grass.
48. *A. stricta* Mx.; Beard grass, Three-awned grass.
49. *A. purpurea* Nutt.; Beard grass, Three-awned grass.
50. *A. desmantha* Trin.; Beard grass, Three-awned grass.
51. *A. oligantha* Mx.; Beard grass, Three-awned grass.
52. *A. purpurascens* Poir.; Tall Beard grass, Triple-awned grass.

13. Stipa L.

a. Awns 4–7 inches long, panicle more or less contracted (*b*).
a. Awns 2–3 inches long, panicle open..... 53
a. Awns 1–1½ inches long, panicle narrow, loose, long..... 55½
b. Panicle loose, 8–12 inches long..... 54
b. Panicle narrow and contracted, base of grain more pointed..... 55

53. *Stipa avenacea* L.; Black Oat grass.
54. *S. comata* Trin. & Rupr.; Porcupine grass, Feather grass.
55. *S. spartea* Trin.; Porcupine grass, Feather grass.
55½. *S. Viridula* Trin.; Bunch Grass, Porcupine grass.

14. Oryzopsis Mx.

a. Awn thrice the length of the blackish flowering glume..... 56

56. *Oryzopsis melanocarpa* Muhl.; Mountain rice.

15. Muhlenbergia Schreb.

a. Panicles contracted or glomerate (*b*).
a. Panicles very loose and open, the long branches capillary..... 64
b. Flowering glumes barely mucronate or sharp-pointed (*c*).
b. Flowering glumes bristle-awned from the tip (*e*).
c. Outer glumes awnless but pointed (*d*).
c. Outer glumes awned, panicle oblong-linear, spike-like..... 58
d. Culms rarely branching, 1–2 ft. high, panicle simple, very slender..... 57
d. Culms much branched, 2–3 ft. high, panicles lateral and terminal, linear..... 59
e. Floret with an oblique callus bearing hairs as long as the floret..... 61
e. Not as above (*f*).

f. Outer glumes bristle-pointed, nearly as long as the flowering glume 60
f. Outer glumes short-pointed, half the length of the flowering glume 62
f. Outer glumes extremely minute, the lower obsolete; culms much-branched 63

57. *Muhlenbergia sobolifera* Trin.
58. *M. glomerata* Trin.; Spiked Muhlenbergia.
59. *M. Mexicana* Trin.; Mexican Muhlenbergia.
60. *M. sylvatica* T. & G.; Wood grass.
61. *M. comata* Benth.; Woolly Muhlenbergia.
62. *M. Willdenovii* Trin.; Willdenows Muhlenbergia.
63. *M. diffusa* Schr.; Nimble Will, Wire grass.
64. *M. capillaris* Kunth.; Hair grass.

16. Brachyelytrum Beauv.

a. Culms 1-3 ft. high, creeping root-stocks, downy sheaths 65

65. *Brachyelytrum aristatum* Beauv.; Short-glumed grass.

17. Phleum L.

a. Spike cylindrical elongated, outer glumes ciliate and bristle-pointed 66

66. *Phleum pratense* L.; Timothy, Herd's grass, Cat's-tail grass.

18. Alopecurus L.

a. Stems upright, ½-2 feet high (*b*).
a. Stems decumbent, bent at the lower joints (*c*).
b. Stems ½-2 feet high, outer glumes with long hairs on the back 67
b. Stem about 2 feet high, awn exserted more than half its length 68
c. Awn from (near base of) outer glume projecting half its length 69
c. Like the last, but glaucous, and awn shorter and arising higher 70

67. *Alopecurus alpinus* Sm.; Alpine Fox-tail.
68. *A. pratensis* L.; Meadow Fox-tail.
69. *A. geniculatus* L.; Water Fox-tail.
70. *A. aristulatus* Mx.; Short-bearded Fox-tail.

19. Sporobolus R. Br.

a. Panicles spiked or contracted (*b*).
a. Panicles generally open (*g*).
b. Outer glumes very unequal (*c*).
b. Outer glumes somewhat equal (*d*).
c. Culms 1½-4 feet high, leaves long (*d*).
c. Culms (6-12 inches high) and leaves very slender, root perennial 74
d. Spikelets 2-3 lines long, lowest leaves rigid, rough on edges 72
d. Spikelets less than one line long, narrow, lowest glume obtuse or truncate 71
e. Root annual, culms ascending, grain linear 73
e. Root perennial (*f*).
f. Outer glumes very acute, flowering glume cuspidate 74
f. Outer glumes obtuse, panicle of few solitary distant erect rays 75
g. Outer glumes purplish, very unlike, upper ovate, grain round 76
g. Not as above (*h*).
h. Rays of panicle verticillate, 8 (or more) at base, fewer above 79½
h. Rays of panicle in pairs or solitary (*i*).
i. Outer glumes very unequal (*j*).
i. Outer glumes nearly equal, stems 6-15 inches, branched or decumbent 79
j. Rays of panicle flower-bearing to base, sheaths strongly-bearded at throat 77
j. Rays naked below, sheaths with a few long hairs at throat 78

71. *Sporobolus Indicus* R. Br.; Smut grass.
72. *S. asper* Kunth.; Rough Drop-seed grass.
73. *S. vaginaeflorus* Torr.; Drop-seed grass.
74. *S. cuspidatus* Torr.; Drop-seed grass.

75. *S. depauperatus* Torr.; Drop-seed grass.
76. *S. heterolepis* Gr.; Drop-seed grass.
77. *S. cryptandrus* Gr.; Drop-seed grass.
78. *S. airoides* Torr.; Salt grass, Drop-seed grass.
79. *S. asperifolius* N. & M.; Drop-seed grass.
79½. *S. Arkansana* (Trin.); Drop-seed grass.

20. POLYPOGON Desf.

a. Panicle dense, soft, yellowish-green; awns conspicuous, long..... 80
a. Panicle narrow, much-lobed, usually purplish; awns shorter..... 81

80. *Polypogon Monspeliensis* Desf.; Annual Beard-grass.
81. *P. littoralis* Sm.; Perennial Beard-grass.

21. CINNA L.

a. Panicle rather dense, branches spreading in flower, spikelets 2½–3 lines long..... 82
a. Panicle loose and more slender, branches drooping in flower, spikelets 1½–2 lines long..... 82½

82. *Cinna arundinacea* L.; Wood Reed grass.
82½. *C. pendula* Trin.; Wood Reed grass.

22. AGROSTIS L.

a. Palet present (*b*).
a. Palet entirely wanting or very minute (*c*).
b. Ligule short and truncate; panicle slender, usually spreading in flower..... 83
b. Ligule long and acute, panicle as above..... 83½
b. Ligule obtuse, flowering glume with a longitudinal furrow on back..... 84
c. Culms firm or stout, 2–3 ft. high; upper ligules 2–3 lines long..... 85
c. Culms slender or very slender, 1–2 feet high (*d*).
d. Stems slender, panicle pale-green, branches fl.-bearing from or below the middle..... 86
d. Stems very slender, panicle purplish, branches fl.-bearing at or near apex..... 87

83. *Agrostis vulgaris* With.; Red-Top, Fine-Top, Borden's grass, Bent grass.
83½. *A. alba* L.; Fiorin, White Bent grass, Red-Top.
84. *A. exarata* Trin.; Northern Red-Top, Mountain Red-Top.
85. *A. elata* Trin.; Bent grass.
86. *A. perennans* Tuck.; Thin grass, Bent grass.
87. *A. scabra* Willd.; Hair grass.

23. CALAMAGROSTIS Roth.

a. Awn delicate, straight, not exceeding the hairs..... 88
a. Awn bent or twisted when dry, surpassing the flowering glume..... 89

88. *Calamagrostis Canadensis* Beauv.; Small Reed-grass, Blue-Joint.
89. *C. confinis* Nutt.; Reed Bent-grass.

24. AMMOPHILA Host.

a. Culms 3–6 ft. high, panicle 4–16 inches long, palet equal and similar to glume..... 90

90. *Ammophila longifolia* Vasey; Long-leaved Reed grass.

25. DESCHAMPSIA Beauv.

a. Awn slender, about as long as fl.-glume, culm 2–4 feet high..... 91
a. Awn about half longer, becoming bent and twisted, culm 1½–2 ft..... 92

91. *Deschampsia flexuosa* Griseb.; Wood Hair grass.
92. *D. caespitosa* Beauv.; Hair grass.

26. DANTHONIA DC.

a. Culms tufted, low, spikelets few, 3–5 lines long..... 93

93. *Danthonia spicata* Beauv.; Spiked Wild Oat grass.

27. SPARTINA Schreb.

a. Culm 3–6 (or more) feet high, leaves 2–4 feet long 94
a. Culm 1–2 feet high, slender, leaves narrow and rush-like 95

94. *Spartina cynosuroides* Willd.; Cord grass, Marsh grass.
95. *S. juncea* Willd.; Marsh grass, Salt grass, Rush Salt grass.

28. CHLORIS Swz.

a. Culm compressed, branched at base, spikes filiform 96

96. *Chloris verticillata* Nutt.

29. GYMNOPOGON Beauv.

a. Flowers on long filiform spikes crowded into a raceme 97

97. *Gymnopogon racemosus* Beauv.; Naked Beard grass.

30. SCHEDONNARDUS Steud.

a. Panicle consisting of slender, naked, triangular spikes 98

98. *Schedonnardus Texanus* Steud.; Texas Spike grass.

31. BOUTELOUA Lag.

a. Spikes pectinate oblong or linear, solitary or few, in a raceme (*b*).
a. Spikes short, in a long virgate one-sided spike or raceme 101
b. Glumes with dark, warty glands and bristly hairs, sterile flower glabrous 99
b. Glumes soft, hairy, pedicel of sterile flower villous-tufted 100

99. *Bouteloua hirsuta* Lag.; Bristly Mesquite, Gramma grass.
100. *B. oligostachya* Torr.; Mesquite grass, Gramma grass.
101. *B. racemosa* Lag.; Tall Gramma grass.

32. ELEUSINE Gaert.

a. Spikes digitate, spikelets on one side of a flattish rachis 102

102. *Eleusine Indica* Gaert.; Yard grass, Crow-foot, Crab grass, Wire grass.

33. LEPTOCHLOA Beauv.

a. Flowers in a long, panicled raceme, spikes slender, numerous 103

103. *Leptochloa mucronata* Kth.; Feather grass, Slender grass.

34. BUCHLOË Englm.

a. Dioecious, very small, pistillate flowers inconspicuous 104

104. *Buchloe dactyloides* Englm.; Buffalo grass, False Mesquite grass.

35. MUNROA Torr.

a. Flowers in leafy heads or clusters; stems rigid, creeping 105

105. *Munroa squarrosa* Torr.; False Buffalo grass.

36. PHRAGMITES Trin.

a. A very tall swamp grass, with a large terminal panicle 106

106. *Phragmites communis* Trin.; Reed grass.

37. TRIODIA R. Br.

a. Panicle large purplish, loose; spikelets lanceolate 107
a. Panicle contracted, 3–5 inches long; spikelets few, ovate, turgid 108
a. Panicle spike-like, dense, 6 in. long, ½ in. wide; spikelets nearly as long as broad 109
a. Panicle dense and ovoid or very simple and of few spikelets (*b*).
b. Stems with usually a single node, panicle ovoid, 1–2 inches long 110
b. Stems with numerous bearded joints, panicles very simple, axillary ones included 111

107. *Triodia cuprea* Jacq.; Tall Red-Top.

108. *T. ambigua* Vasey.
109. *T. stricta* Vasey.
110. *T. acuminata* Vasey.
111. *T. purpurea* Vasey; Sand grass.

38. Redfieldia Vasey.

a. Culms flexuous, leaves rigid, panicles lax 112

112. *Redfieldia flexuosa* Vasey.

39. Diplachne Beauv.

a. Panicle 6–10 inches long, with 15–30 branches, flowering throughout 113
a. Panicle erect, stiff, 1–2 feet long, with numerous spreading spike-like branches 114

113. *Diplachne fascicularis* Beauv.; Spike grass.
114. *D. rigida* Vasey; Spike grass.

40. Eragrostis Beauv.

a. Stems erect or diffusely spreading and ascending (*b*).
a. Prostrate and creeping, spikelets clustered, linear lanceolate, 10–30-flowered 115
b. Culms branching and decumbent or spreading at base, panicle narrow (*c*).
b. Culms simple or branching only at base, rigid, erect, panicle very large (*f*).
c. Spikelets mostly large, 4–9 lines long, 10–20-flowered (*d*).
c. Spikelets mostly small, 1–4½ lines long, 2–18-flowered (*e*).
d. Panicle oblong or pyramidal, full-flowered, spikelets oblong or lanceolate, 3–6 lines long 116
d. Panicle 4–6 inches high, narrow, spikelets 4–9 lines long, leaves becoming involute 120
e. Spikelets 5–12-flowered, 2–4 lines long, about equaling their pedicels 117
e. Spikelets 2–5-flowered, 1–1½ lines long, on slender pedicels 118
e. Spikelets 5–18-flowered, 2–4½ lines long, mostly shorter than pedicels 119
f. Panicle 1–2½ feet long, virgate, very loose, leaves 1½–2 feet long 120½
f. Panicle widely expanding and diffuse (*g*).
g. Panicle mostly naked in axils, spikelets 2–4-flowered, very small 121
g. Bearded in the axils, spikelets 5–15-flowered, large, 2–3 lines long 122

115. *Eragrostis reptans* Nees.; Creeping Eragrostis.
116. *E. major* Host.; Stinking grass, Pungent Meadow grass, Candy grass.
117. *E. pilosa* Beauv.
118. *E. Frankii* Mey.
119. *E. Purshii* Schrad.
120. *E. oxylepis* Torr.
120½. *E. tenuis* Gray.
121. *E. capillaris* Nees.
122. *E. pectinacea* Gray.

41. Eatonia Raf.

a. Panicle dense and contracted, second glume broad and saccate 123
a. Panicle long and slender, loose, second glume not so broad 124

123. *Eatonia obtusata* Gr.; Obtuse Eatonia, Prairie grass.
124. *E. Pennsylvanica* Gr.; Eastern Eatonia, Prairie grass.

42. Koeleria Pers.

a. Panicle narrowly spiked, interrupted or lobed at the base 125

125. *Koeleria cristata* Pers.; Crested Koeleria, Prairie grass.

43. Melica L.

a. Panicle simple or little branched 126
a. Panicle larger and more branched 126½

126. *Melica mutica* Walt.; Melic grass.
126½. *M. mutica* Walt., var. *diffusa* Gr.; Melic grass.

44. DIARRHENA Raf.

a. Simple culm with long, linear-lanceolate flat leaves at base..... 127

127. *Diarrhena Americana* Beauv.

45. UNIOLA L.

a. The *very* broad, flat spikelets on drooping pedicels..... 128

128. *Uniola latifolia* Mx.; Broad-flowered Fescue grass.

46. DISTICHLIS Raf.

a. Leaves rigid and sharp-pointed, glumes many-nerved, coriaceous..... 129

129. *Distichlis maritima* Raf.; Salt grass, Marsh grass.

47. DACTYLIS L.

a. Upper branches of panicle short, lower, longer and spreading..... 130

130. *Dactylis glomerata* L.; Orchard grass, Cock's-foot grass.

48. POA L.

a. Flowering glumes compressed-keeled, acute (*c*).
a. Flowering glumes rounded on the back, obtuse (*b*).
b. Spikelets 3-7-flowered, outer glumes acute, rough on the back..... 131
b. Spikelets mostly 3-flowered, outer glumes very acute, rough on the mid-nerve..... 132
c. Low and spreading, 3-6 in. high, from an annual or biennial root, flaccid..... 133
c. Culms 6-20 in. long, geniculate-ascending, rigid, very much flattened..... 134
d. Spikelets mostly numerous, and crowded on rather short, rough branches (*e*).
d. Spikelets fewer and more scattered on slender pedicels, flowering early (*f*).
e. Ligules elongated, flowering glume very obscurely nerved, spikelets narrow..... 135
e. Ligules short and blunt, flowering glume 5-nerved, hairy along the margin and keel..... 136
e. Ligules oblong, acute, flowering glume prominently 5-nerved, naked at the margins..... 137
f. Spikelets 3-4 lines long, flowering glume conspicuously scarious-tipped..... 140
f. Spikelets 1-2 lines long, flowering glume scarcely scarious-tipped (*g*).
g. Flowers oblong, obtuse, branches of panicle in fives or more..... 138
g. Flowers and glumes acute, branches of panicle in threes or fours..... 139

131. *Poa andina* Nutt.; Mountain Spear grass.
132. *P. tenuifolia* Nutt.; Oregon Blue grass.
133. *P. annua* L.; Annual Spear grass, Goose grass.
134. *P. compressa* L.; Wire grass, Blue grass.
135. *P. serotina* Ehr.; Fowl Meadow grass, False Red-Top.
136. *P. pratensis* L.; June grass, Ky. Blue grass, Spear grass, Meadow grass.
137. *P. trivialis* L.; Rough-Stalked Meadow grass.
138. *P. sylvestris* Gr.; Meadow grass, Spear grass.
139. *P. alsodes* Gr.; Tall Blue grass, Wood Spear grass.
140. *P. flexuosa* Muhl.; Meadow grass, Spear grass.

49. GLYCERIA R. Br.

a. Flowering glume conspicuously nerved, styles present (*b*).
a. Flowering glume inconspicuously 5-nerved, stigmas nearly sessile..... 145
b. Spikelets linear, ¼ inch long, appressed, terete; panicle narrow..... 144
b. Spikelets ovate, oblong, or linear-oblong, 1-3 lines long (*c*).
c. Spikelets ovate, at length very broad and tumid, 2 lines long..... 141
c. Spikelets very numerous, ovate-oblong, 3-7 flowered, 1-2 lines long..... 142
c. Spikelets oblong, or linear-oblong, 5-9 flowered, about 3 lines long..... 143

141. *Glyceria Canadensis* Trin.; Rattlesnake grass, Tall Quaking grass.
142. *G. nervata* Trin.; Nerved Meadow grass, Nerved Manna grass.
143. *G. aquatica* Sm.; Reed Meadow grass, White Spear grass.
144. *G. fluitans* R. Br.; Floating Manna grass.
145. *G. distans* Wahl.; Manna grass.

50. Festuca L.

a. Flowers awned or bristle-pointed (*b*).
a. Flowers awnless or nearly so (*d*).
b. Awns conspicuous, about equaling or exceeding the flowering glume... 146
b. Awns much shorter than the lanceolate flowering glumes (*c*).
c. Panicle few-flowered, contracted; spikelets ovate, about 4-flowered... 147
c. Panicle oblong, spreading; spikelets nearly terete, 5-7-flowered... 148
d. Panicle contracted, with short ascending branches (*e*).
d. Panicle very loose, with spreading or reflexed branches (*f*).
e. Spikelets 6-9-flowered, 6-9 lines long, leaves a foot long... 150
e. Spikelets 2-5-flowered, about 3 lines long, leaves about 8 in. long... 149
f. Spikelets 3-5-flowered, 3 lines long; culm 2-4 feet high... 151
f. Like the last, but stouter, and spikelets about 5-flowered... 152

146. *Festuca tenella* Willd.; Small Fescue.
147. *F. ovina* L.; Sheep's Fescue grass.
148. *F. duriuscula* L.; Harsh Fescue grass.
149. *F. elatior* L.; Meadow, or Tall Fescue; Randall, or Evergreen grass.
150. *F. pratensis* Huds.; Meadow Fescue grass.
151. *F. nutans* Willd.; Drooping Fescue.
152. *F. Shortii* Kunth.; Short's Fescue.

51. Bromus L.

a. Lower glume 3-5-nerved, second glume 5-9-nerved (*b*).
a. Lower glume 1-nerved, second glume 3-nerved or obscurely 5-nerved... 158
b. The awn small or scarcely any (*c*).
b. The awn evident or conspicuous (*d*).
c. Panicle 6-10 inches long, spikelets 1-1½ inches long... 153
c. Panicle 4-6 inches long, spikelets oblong-ovate, turgid... 154
d. Awn as long as or longer than the flowering glume (*e*).
d. Awn shorter (*f*).
e. Spikelets oblong-ovate, turgid, sheaths sometimes hairy... 155
e. The conical-ovate spikelets and leaves downy... 156
f. Panicle spreading, spikelets of 8-10 rather distant flowers... 154
f. Panicle simple, small; spikelets 7-12-flowered, densely silky... 157

153. *Bromus unioloides* Willd.; Schrader's grass, Rescue grass.
154. *B. secalinus* L.; Cheat, Chess.
155. *B. racemosus* L.; Upright Chess.
156. *B. mollis* L.; Soft Chess.
157. *B. Kalmii* Gray; Wild Chess.
158. *B. ciliatus* L.; Ciliate Chess.

52. Lolium L.

a. Spikelets 7-11-flowered, awnless or short-awned... 159

159. *Lolium perenne* L.; Rye grass, Italian Rye grass.

53. Agropyrum Beauv.

a. Awn when present not longer than the flowering glume (*b*).
a. Flowering glume and sometimes the outer glumes long awned (*c*).
b. Culm 2-3 feet high, spike narrow, close, 3-6 inches long... 160
b. Like the preceding, but no running root-stocks, spike narrow, slim... 160½
b. Like the first, but more rigid and stouter, of a light bluish-green color... 161
c. Spike more or less nodding (not strict), awn of flowering glume twice its length... 162
c. Spike rigid and strict, awn of flowering glume half or fully its length... 163

160. *Agropyrum repens* Beauv.; Couch, Quick, Quitch, Wheat, Twitch or Dog grass.
160½. *A. tenerum* Vasey; Wheat grass, Clump Wheat grass.
161. *A. glaucum* R. & S.; Western Wheat grass, Colorado Blue-Joint, Colorado Blue-Stem, Wild Quack grass, Gumbo grass.

162. *A. caninum* Reich.; Wheat grass.

163. *A. violaceum* Beauv.; Wheat grass.

54. HORDEUM L.

a. Awns about 2 inches long, spike bushy in appearance 164
a. Awns about ½-inch long, spike not so bushy 165

164. *Hordeum jubatum* L.: Squirrel-tail grass.

165. *H. pusillum* Nutt.; Small Squirrel-tail grass.

55. ELYMUS L.

a. Culms rather tall, 2–5 feet high, outer glumes with short or long awns (*b*).
a. Culms about a foot high (seldom 2 ft.), outer glumes long awned 169
b. More or less pubescent, spike usually slender, awn 1 inch long 168
b. Plant (except sometimes the flower) not pubescent (*c*).
c. Spike rigidly upright, peduncle short, often included in sheath 166
c. Spike (5–9 in. long) soon nodding, on an exserted peduncle 167

166. *Elymus Virginicus* L.; Wild or Smooth Rye grass, Terrell grass.

167. *E. Canadensis* L.; Wild Rye, Lyme grass, Terrell grass.

168. *E. striatus* Schultz; Rye grass, Dennett grass.

169. *E. Sitanion* Schl.; Rye grass, Small Western Rye grass.

56. ASPRELLA Willd.

a. Spike loose, 3–6 inches long, spikelets early deciduous 170

170. *Asprella hystrix* Willd.; Bottle-brush grass.

THE HUMAN EYE: THE CHANGES WHICH OCCUR IN MIDDLE LIFE.

BY W. D. BIDWELL, A.M., M.D., LEAVENWORTH, KANSAS.

The following are the changes which occur in the eye in or near middle life, which we will consider briefly:

First, that condition known as Presbyopia, or the sight of old age.

Second, Cataract.

Third, Myopia, or near-sightedness.

Fourth, Epiphora, or the overflow of tears upon the cheek.

The condition known as Presbyopia is due to a change in the consistency of the crystalline lens. In infancy the lens is composed of a somewhat elastic substance, held in position by a membrane known as the suspensory ligament; the posterior surface is more convex than the anterior, but when the suspensory ligament is relaxed the natural elasticity of the lens causes it to become more convex, particularly anteriorly, bringing the focus nearer the eye and at the same time the iris contracts, shutting out rays which would be rendered too divergent to come to a focus on the retina. In process of time the lens grows larger, heavier and less elastic, so that the focal distance for the eye or the distance of the near-point, as it is called, becomes greater, and when it exceeds ten inches, which is usually between the ages of forty and forty-five years, reading becomes tiresome or impossible, because at the distance at which the book is ordinarily held, the whole accommodation (that is, relaxation of the ligament referred to above) which is available has to be used, and hence fatigue is soon experienced; while if the book is held further away only large print can be read, because of the diminution in the size of the retinal images. The remedy for this is supplementing the accommodation by convex spectacles of such a strength as to bring the near-point back to nine inches. The hardening of the lens

being progressive, it becomes necessary to use a stronger glass every few years. Presbyopia may occur before the age of forty, but is to be distinguished from Hypermetropia, or far-sightedness, a condition due to a shortening of the globe of the eye itself, which may be congenital, or develop at an early age. The two are often confounded, owing to the fact that a convex glass is worn in either case; but hypermetropia is far more difficult of correction, owing to the fact that it is rarely detected in its incipiency, and in the effort to bring rays of light from near objects to a focus on the retina the patient strains the accommodation, producing a condition of spasm, sometimes associated with squinting, and this spasm is very difficult to relax. Jewelers and trade dealers in spectacles frequently fail to give satisfaction in fitting glasses, because they do not understand the pathology of spasm, and a glass which suited the patient in the store may prove very unsatisfactory when worn constantly for an hour or two at home.

Cataract, so called from its causing a blindness like that of a veil falling over the eye, is a cloudy or opaque condition of the crystalline lens, which prevents the passage of rays of light to the retina. The causes are still obscure; but it occurs more often with certain diseases such as diabetes and ergotism, after injuries to the eye, in persons of dissipated habits, and often with no other apparent cause than the lowering of vitality due to advancing years. The ordinary senile cataract is of slow formation, from two to four years intervening between the first symptoms and that condition of hardness in which it is said to be ripe. The opacity may begin in the center, at the periphery, or at the poles. When it begins in the center or at the poles there is better vision on dark or dull days, or when the eye is shaded, for then the pupil dilates, and rays pass through the as yet unclouded periphery of the lens. The symptoms of cataract are: Failing vision, unimproved by glasses, and more marked in one eye than in the other. Later, the pupil, which formerly was black, shows a cloudy gray or purplish appearance; and examination by oblique illumination and the use of the ophthalmoscope shows the seat and extent of this cloudiness. During the earlier stages of cataract, the fundus of the eye can be seen with the ophthalmoscope, and it is very important that a careful examination should be made at this time, to determine the advisability of an operation when the whole lens becomes opaque. No treatment is of any avail, except removal of the lens when it is ripe, or, in selected cases, the making of an artificial pupil by removing a small portion of the iris from in front of a clear portion of the lens. Even when a cataract is ripe the patient is not absolutely blind, for, when placed facing a window, he will detect a hand passed between him and the light, and in a dark room he is able to tell the position of a lighted candle placed before him or at one side. When this perception of light is lost, there is some other defect, and operation is not advisable; but in all ordinary cases, after the cataract is removed, very good vision is secured by placing strong convex lenses in front of the eye. It must be remembered, however, that the accommodation is lost, and lenses of different foci are required for seeing at varying distances.

Several of the leading oculists have made themselves famous by devising new operations for cataract. Formerly the lens was dislodged from its position by needles, and pressed back into the vitreous humor; but now the favorite operation is to remove the lens bodily by an incision through the cornea, and the principal difference of opinion is as to the advisability of removing a portion of the iris first, or pressing out the lens, and running the risk of bruising the iris during the operation.

Dr. Valk, with whom I spent some time during a recent period of study in New York, has devised an operation by which he presses back the iris with retractors during the exit of the lens, thus avoiding the dangers of inflammation of the iris, and securing a perfectly round and movable pupil after the operation.

Before leaving the subject of cataract, I will just mention one fact that is frequently misleading. In commencing cataract, the refractive power of the nucleus of the lens may be increased so that one who had been compelled to wear convex glasses for presbyopia is enabled to leave them off: hence, they imagine their sight is improving with age, whereas it is on the road to a more rapid failure.

Having referred to hypermetropia, or far-sightedness, in connection with presbyopia, it would not be quite fair to entirely ignore the opposite condition of myopia, or near-sightedness, as it is called. Myopia is usually due to a lengthening of the globe of the eye, as a result of weakness of the tunics. It may be congenital, but more often comes on during childhood. The employment of the eyes, in childhood, for near work, with a defective light, the head being bent over, will make the trouble much worse, if, indeed, it is not sufficient to originate myopia. A feeble condition of the system tends to increase the trouble, and in many cases the vitreous finally becomes fluid, and opacities are seen in it and in the lens. With proper care, the disease progresses but slowly in the majority of cases; but with abuse of the eye, stronger glasses are required at frequent intervals, and the vision becomes very feeble. The remedy consists in wearing a proper glass, and in avoiding the causes already mentioned.

The only other disease I will refer to at this time is Epiphora, or the overflow of tears upon the cheek. Normally the tears are discharged through several small canals coming from the lachrymal sac in the upper and outer corner of the orbit, over the front of the eye, and are taken up through two minute orifices, called the puncta lachrymalia, situated one in the upper and one in the lower lid at the inner angle of the orbit. These two open into canaliculi, which unite and form the lachrymal sac, and this in turn opens into the nasal duct discharging the tears into the nose. The orbicularis muscle, which closes the lids, sharing in the general diminution of vitality of the system, may become relaxed, and the puncta are then no longer applied to the surface of the globe, but point outward, and allow the tears to escape upon the cheek, giving rise to inflammation of the skin, and the unsightly appearance noticeable in many aged people. These cases are sometimes entirely relieved by the simple operation of opening up the canaliculi so that the tears are readily received into the sac; but others are only relieved by dilating the whole nasal duct, which evinces a decided inclination to close up if irritated by acrid discharges from the eye.

AN EXAMINATION OF THE RESINOUS EXUDATION OF ROSIN WEED.

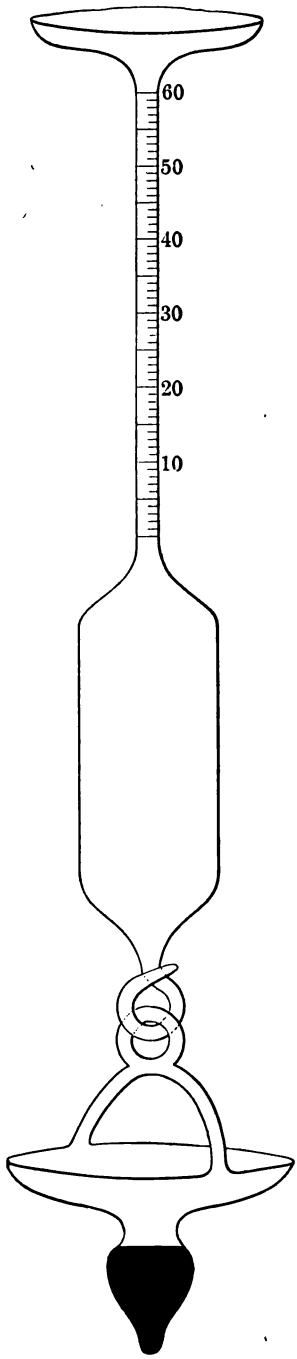
(*Silphium Laciniatium.*)

BY PROFESSOR L. E. SAYRE.

(Abstract.)

The rosin weed exudes a resinous juice, which congeals in small transparent or translucent masses or tears. This resin is quite beautiful and interesting, and, it seemed to me, could be made of value in making a fluid for use in microscopic mounting.

On examination, this deposit proved to be quite a pure oleo-resin. It is soluble in chloroform, benzol, ether, and benzine. Alcohol and methyl alcohol dissolve it to some extent. The chloroform and benzol solutions are perhaps the best for microscopic purposes. They leave, upon spontaneous evaporation, a transparent residue. If the solution is evaporated, and the heat continued until the volatile oil is driven off, the residue makes a solution in benzol or chloroform which dries very rapidly into a thin, transparent film, which is well adapted to microscopic mounting.



A NEW FORM OF HYDROMETER.

BY G. H. FAILYER,

Kansas State Agricultural College, Manhattan.

The writer has had charge of a large class in determinative mineralogy, and found it inconvenient and expensive to supply them with sufficient appliances for getting the specific gravity of the minerals. The Jolly balance answered a good purpose, the errors in its use not being greater than the variations in the gravity of the minerals themselves. But the price of the balance led to the wish for something equally rapid and accurate, and of such price that a number of them might be placed at the disposal of the students. He therefore devised a combination of the Nicholson and the Beaumé hydrometers, such that the work can be done with more satisfaction than with the Jolly balance, and the instrument is quite inexpensive. The accompanying cut will fully show its form.

It was neatly made for me by E. Greiner, of New York. Its essentials, of course, are the two pans and the graduated stem. The more slender the stem, the less, proportionately, the error in reading.

Its use is almost obvious from the instrument itself. There is no fixed water-line, but the graduation extends somewhat below the surface of the water as the unloaded instrument floats in its jar. The readings and calculations are exactly similar to those made in using the Jolly. First, the position of the instrument in the water is noted. This is best done by reading through the water (that is, at the lower instead of the upper surface of the film separating the water and the air), where the plane of the water cuts the stem. By this means, the meniscus gives no trouble. The solid is then placed in the upper pan and another reading taken. A third reading is taken, this time with the substance in the lower pan. The first reading subtracted from the second will give a number representing the weight of the substance; the third from the second, the displaced water. The gravity is then found in the usual way.

By making the stem small, the accuracy of the instrument is increased. In a comparison of one with the Jolly balance, I obtained these results with the same piece of barite: With the Jolly, 4.519, 4.523, 4.471, average 4.504, greatest difference .052; with the new hydrometer, 4.472, 4.475, 4.460, average 4.469, greatest difference .015. But it is not claimed that results are more accurate by this instrument than by the Jolly balance. It is cheaper and more convenient. I have observed that where both are accessible to students, they will use the hydrometer in preference to the balance.

IN REGARD TO COLOR-BLINDNESS AMONG INDIANS.

BY L. I. BLAKE AND W. S. FRANKLIN, STATE UNIVERSITY.

The fact that blindness to certain colors exists among civilized people, is well established; also, the percentage of cases to be found among males has been determined with considerable probability for the races of Europe and America. There has been much diversity in methods of testing, and the results of many reported determinations might well be called into question. Still, it is probably not far from the truth that four out of every hundred males are more or less deficient in color-sense. Of females, there have been reported (B. J. Jeffries, M. D., "Color-Blindness," p. 74), as examined in Europe and America, 39,828, and of these only 60 were color-blind, or 2 per cent. Of both males and females, 156,732 have been tested, and of these, 6,721, or 4.27 per cent., are color-blind. These statistical facts have naturally excited interest and discussion. If so large a number as four out of every hundred are unable to distinguish colors, there arises, of course, a practical question, important to the railroads, marine, etc.

The gravity of this fact is already recognized more or less in all countries, by the test examinations for color-blindness among employés. But there is in these statistics also much of interest to scientists.

Most cases of color-blindness are found to be congenital, and are incurable Many have been produced by disease, some by violent concussions in accidents, and some by excessive use of tobacco and alchohol. Temporary blindness to violet may be induced by santonine. From these facts several interesting questions have suggested themselves to us. If color-blindness follows the laws of heredity, is it on the increase, or decrease? Further, is it a product of civilization? The first of these queries can be answered only by statistical data extending over long periods of time. The second naturally suggests a comparison: first, of the color-sense of civilized nations among themselves; and second, of civilized with uncivilized peoples.

Of tests on native tribes, we can find but two recorded—those of Dr. Favre on some tribes in Algiers, and those of Dr. Fox on 150 American Indians, but where we do not know.

First, for the comparison of civilized tribes among themselves, we have calculated the following percentages from tables reported by Dr. Jeffries:

COUNTRIES.	*No. examined.*	*Per cent. color-blind.*
Austria	5,250	3.79
Denmark	5,840	3.74
Belgium	8,106	4.13
Holland	2,300	1.43
Finland	1,200	5.00
Norway	205	4.88
Sweden	32,504	3.73
Switzerland	3,024	5.36
Germany	6,344	4.12
Russia	12,830	3.30
Italy	2,065	2.32
England	16,431	3.75
United States	44,844	3.64
Average per cent		3.76

No great reliance can be placed upon these results. The numbers examined are too small, the methods of testing not uniform, not equally reliable. However, the probabilities of error are about equally distributed; so that the conclusion is fairly

observer at the latter station, in the year 1876, noting the fact that the instrument at Lawrence recorded more than twice as much wind as the Leavenworth instrument, criticised the records of the University anemometer as palpably erroneous, fortifying the criticism by the statement that no other stations, except those on Pike's Peak, Colorado, Mt. Washington, New Hampshire, and other high mountain stations, could equal the records at Lawrence. In order to test the accuracy of our records, Mr. John H. Long, of the class of 1877 of the Kansas University, now the distinguished professor of chemistry in the Chicago Medical College, was induced to make a thorough investigation of the question. The results of this investigation are to be found in vol. VI of the Transactions of this Academy, pp. 87–89. Dr. Long established the following facts regarding the University anemometer: 1st, That it never registers too much; 2d, that for medium and high winds it makes a very close approximation to the actual velocity; and 3d, that for small velocities it does not register enough. This is due to the fact that a gentle breeze sufficient to give a positive direction to a column of smoke will sometimes fail to move the cups for many minutes. This instrument is after the English pattern, with cups nine inches in diameter on arms twenty-four inches in length, and is connected with the recording apparatus by a shaft whose upper and lower portions are of solid steel for a distance of three feet, while the intervening portion consists of twenty-five feet of three-fourths-inch gas pipe. The weight and friction of this shaft are sufficient cause for the failure of the cups to readily respond to winds of less than five miles an hour, and are also sufficient to more than overcome the twenty-per-cent. advantage which, according to the English Professor Stokes, is possessed by this large type of anemometer over the smaller instrument in use by the U. S. Signal Service, with cups four inches in diameter on arms only seven inches in length. By the courtesy of the Signal Service, I have had the use of one of these smaller anemometers during the past year. This instrument has the same exposure as the larger instrument, and has afforded another means of testing its accuracy. The following is a comparison of the records of the two anenometers from March 10th to October 1st, 1888:

Month.	*Larger Anemometer.*	*Smaller Anemometer.*
March	10,130 miles.	9,522 miles.
April	12,860 "	12,313 "
May	10,956 "	10,871 "
June	10,380 "	10,365 "
July	7,160 "	7,980 "
August	7,841 "	8,367 "
September	6,903 "	7,127 "
Total	66,230 miles.	66,545 miles.

From this tabular statement it appears that in March, April, May and June, in each of which months the total run of the wind exceeded 10,000 miles, the larger instrument recorded respectively 608, 547, 85, and 15 miles more wind than the smaller instrument; while in the calmer months of July, August and September the smaller instrument outran the larger by 820, 526, and 224 miles. For the entire period in which the comparison is made, the total register of the larger anemometer was 66,-230 miles, and that of the smaller was 66,545 miles—giving a difference of only 315 miles in the total results. During the seven months included in this comparison, occurred the highest wind ever recorded at Lawrence. Undoubtedly higher winds have swept across the station; but such winds have disabled the apparatus, and prevented a record. The greatest velocity ever recorded was on August 12th, 1888, in the five minutes from 2:25 to 2:30 A. M., when by the smaller instrument eight miles were registered, or at the rate of 96 miles an hour. The larger instrument registers

at ten-mile intervals, instead of one-mile intervals, and consequently an exact five-minute comparison cannot be made; but one ten-mile run was made in 6.45 minutes, which is at the rate of 93.3 miles per hour. Neither set of cups was blown off or in the least disabled by this wind. It was a result entirely unexpected by the writer, that the two anemometers should so closely correspond in their aggregate and maximum velocities. The period under discussion includes the three calmest months of the year, and consequently the smaller instrument has a slight advantage over the larger in total returns. It will probably be found, when we are able to include one entire year in the comparison, that the larger cups will have a very slight advantage over the smaller; but the difference between the total velocities of these instruments is so minute as hardly to be worthy of consideration.

MINERAL WATERS.

G. H. FAILYER AND C. M. BREESE,
Kansas State Agricultural College, Manhattan.

In reporting the results of the analyses of mineral waters made during the year, we have followed the recommendation of the committee appointed by the Chemical Section of the A. A. A. S., to report upon best methods of stating results*: that is, the basic elements are given as such, not as oxides, as was usual previously; the acidic elements are given as such, if directly combined with a basic element; if in the form of an oxygen acid, the whole of the oxygen of the salt is given in stating the amount of the acid. Instead of giving magnesium sulphate ($MgSO_4$) as MgO and SO_3, it is now given as Mg and SO_4. Chlorine is given, and not hydrochloric acid, the element chlorine being directly combined with the metal, as in NaCl.

The amounts are given in parts per thousand. The specific gravity of a water containing so little in solution is appreciably one, and these amounts may be taken as giving the grams per litre. Multiplied by 58.3 they will give approximately the grains per U. S. gallon. The results can thus be readily reduced to this form by those who so desire; but of the three forms, that of parts per thousand is the simplest statement of the strength of a solution. These are ratios that can be seen readily, while it requires more than ordinary familiarity with these units to enable one to perceive the relation of solids to the liquid in which they are found, when stated as grains per gallon.

No. 1 is from Burr Oak, Kansas.

No. 2 is from Conway, Kansas.

No. 1.	*Parts per 1000.*
Potassium	Trace.
Sodium	.3170
Lithium	.0008
Calcium (as bicarbonate)	.0038
Calcium (not as bicarbonate)	.4585
Magnesium (as bicarbonate)	.0015
Magnesium (not as bicarbonate)	.3733
Alumina	.1175
Iron (as bicarbonate)	.0144
Sulphuric acid (SO_4)	2.9407
Chlorine	.1051
Phosphoric acid	Trace.
Boric acid	Trace.
Silica	.0883

Combined and free carbonic acid not determined.

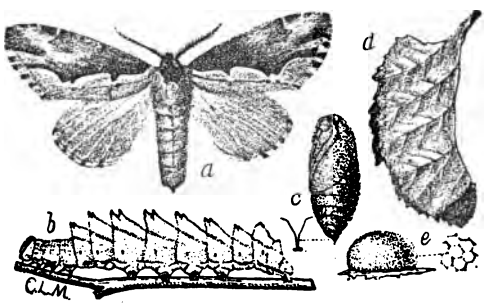
*See Proceedings American Association for the Advancement of Science, 1887, page 143.

No. 2.	Parts per 1000.
Potassium	.0192
Sodium	.0386
Lithium	Trace.
Calcium	.5215
Magnesium	.0947
Alumina	.0104
Iron	Trace.
Sulphuric acid (SO_4)	1.6546
Chlorine	.0595
Boric acid	Trace.
Silica	.0143

No carbonates present.

NOTES ON THE EARLY STAGES OF THREE MOTHS.

BY C. L. MARLATT, STATE AGRICULTURAL COLLEGE, MANHATTAN, KANSAS.



NERICE BIDENTATA WALKER.

a, moth; *b*, larva; *c*, pupa; *d*, pupa-case of folded leaf; *e*, the egg, enlarged, with outline of the surface pattern, much magnified. Excepting *e*, the figures are of the size of nature.

Eight or ten nearly full-grown peculiar saw-backed larvæ, which proved to be of the above-named moth, were collected on young elm-shoots growing in the College grounds, September 13, 1887. A number of whitish, hemispherical eggs with irregular openings at the apex through which the larvæ had escaped, were found on or near the eaten leaves, attached singly to the upper surface of the leaf.

Cocoons of stout, brownish silk were constructed by the larvæ shortly after collection (Sept. 14–21) in folded leaves, or under some slight protection at the surface of the soil, concealed by particles of earth.

A considerable time elapsed before the pupal stage was assumed.

Moths appeared May to June, and deposited eggs in the breeding-cage exactly similar to those found on the leaves the previous September. The eggs failed to hatch, much to my regret, and the early larval changes cannot be given. It is safe to assume, however, that this moth is double-brooded—the moths from which my specimens were obtained probably appearing about the first of August.

I have failed to find any reference to the early stages of this insect in the entomological works at my command, and the following descriptions of early stages are given in the belief that they have not hitherto been recorded:

Egg: .9x.55 mm. Shape, hemispherical, with a broad flattened base, irregularly encircled by a whitish cement, fastening it to the leaf. Surface shining, apparently smooth, but when highly magnified is found to be covered with raised lines inclos-

ing minute polygonal, usually 6-sided, areas. Color, honey yellow; after hatching, nearly white.

Mature larva: Length, 32 to 35 mm. Head, resinous, slightly bilobed—a narrow brownish stripe marking each lobe in front. Mouth-parts light, mandibles tipped with dark. Body moderately robust, especially at center. Thoracic segments small. Abdominal segments 3–11, armed dorsally with large, fleshy bi-toothed elevations, increasing in size from 4th to the 6th segment, then diminishing to the 10th. The elevation on the 11th segment is considerably larger than that of the preceding segment, and has but one point. Tips of all the protuberances, crimson. Body, greenish: upper half of sides washed with white, interrupted by a central dorsal hyaline line, and an oblique hyaline line extending from the dorsal suture to the lower edge of the white on each segment.

A dull, crimson band marks the lower edge of the thoracic segments, and segments 11 and 12, continuing on the last to the tips of the anal prolegs. A spot of the same color marks the lower edge of segments 4, 5, and 10.

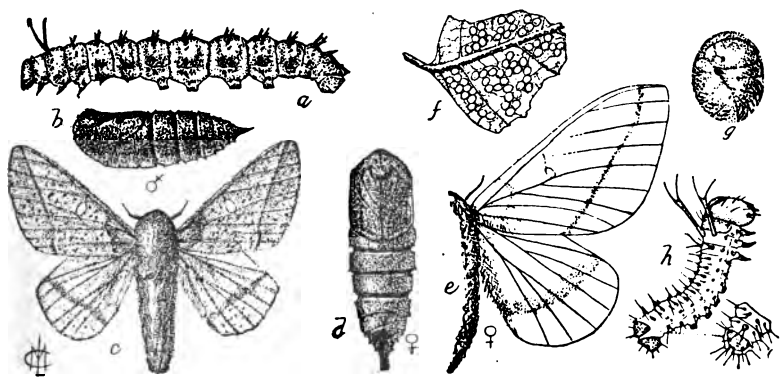
Abdominal feet exteriorly dull crimson, transversely lined with black.

Thoracic feet resinous, with a brownish line or dot on the outer side.

Venter, greenish. Stigmata, black.

Pupa: 16x6 mm. Robust; dark reddish brown; last segment armed with a shining spine, forked, and recurved at the tip (see fig. *c*)—(wanting in one specimen, uniformly present in 4 others examined). Wing and feet cases, etc., extend nearly to the posterior margin of the 4th abdominal segment, and are deeply rugose. Abdominal segments punctate, shining: the three sutures including the 5th and 6th abdominal segments prominent, edges produced into minute ridges.

Stigmata elongate, not prominent.



ANISOTA STIGMA FABR.

a, larva full grown; *b*, pupa of male; *c*, male adult; *d*, pupa of female; *e*, outline of right half of female adult; *f*, eggs on oak leaf; *g*, egg near hatching, showing larva within; *h*, newly-hatched larva with detail of supra-anal plate; *g* and *h* much enlarged; the other figures the size of nature.

During August and September the gregarious larvæ of the above-named moth are quite commonly found on our native oaks, feeding in companies of ten to fifty or more. The leaves are eaten entire, except coarser veins, even by newly-hatched larvæ; and limbs and small trees are frequently entirely defoliated by more mature worms. On falling, the young larvæ attach a thread to the leaf by means of which it may be regained; half-grown to mature larvæ have not this habit, and are not easily induced to fall. After attaining full size, early in September, the larvæ enter the soil an inch or more and construct earthen cocoons, in which the pupal stage is assumed seven or eight days later.

Moths emerge late the following summer, July 1st to 15th; and after pairing, deposit eggs in compact groups of 10 to 50 on the lower surface of oak leaves.

Larvæ appear eight or nine days after the eggs are deposited; and, before reaching maturity, moult or shed their skins four times. The first moult occurs after a feeding period of about five days, the second to the fourth after eight to ten days, and about nine days elapse after the fourth moult before they become full-fed and enter the soil.

The following is a record of a cluster of eggs deposited on a leaf of *Quercus prinos* July 11th, 1888:

July 20, larvæ.
August 4–5, first moult.
August 12–13, second moult.
August 20–21, third moult.
August 30–31, fourth moult.
September 9–11, full-fed.
September 14–16, pupæ.

DESCRIPTIONS OF EARLY STAGES.

Egg: Yellowish; oval flattened, 1.7x1.5x1 mm.; apparently smooth, shining; under high power marked with indistinct polygonal raised sculpturings. Before hatching, the brownish head outline of the body, location of spines, etc., of the larva are visible.

Young larva: Length, 3.5 mm.; head, large, .8 mm. wide, 1 mm. long, reddish brown; thoracic and anal plate, large plates on anal prolegs, tubercles and spines, dark reddish brown; general body color, yellowish. The body is armed with hairs and spines as follows: Two large spines 1 mm. long, forked at the apex on the dorsum of the 2d segment; below these on either side is a two-forked spine, and a substigmatal twin spine; spine on 3d segment the same, but the dorsal spines are not larger than the others; on the following segments the dorsal and subdorsal spines are one-pronged, and a small spine or hair appears below and posterior to each of the dorsal spines; on the 11th segment, one central dorsal two-forked spine is found; head, thoracic and anal plates, armed with hairs (or spines). Stigmata, light brown.

Larva after first moult: Length, 10 mm.; spines on second segment 2.5 mm. long, not much forked; spines of body relatively shorter; all spines tuberculate, tubercles bearing minute hairs; color of spines, bluish black; of head and body, reddish; the latter yellowish above, and marked with a subdorsal yellowish stripe; stigmata, black; feet and plates on prolegs, dark.

Larva after second moult: Length, 12 mm.; spines on second segment, 4.5 mm.; body colors darker than in previous stage; a wide, brownish dorsal stripe, including the two dorsal spines on each segment, extends from the second segment to the middle of the last; this stripe is bordered with a lighter or yellowish color, which becomes darker gradually to the dark-brown stigmatal area; below the stigmata, light brown; a few whitish granules or minute tubercles are found on the anterior edge of the first segment, and on the spines.

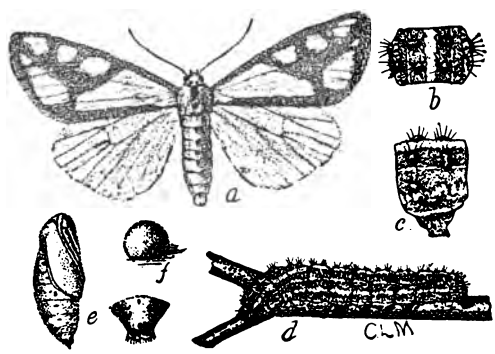
Larva after the third moult: Length, 16 mm.; spines on second segment, 7 mm.; tubercles on spines, and on segments, especially on anterior edge of first and posterior edge of last, white; colors as previously noted.

After the fourth moult: Length, 30 mm; full-fed, 40–45 mm.; spines on second segment, 6.5 mm. long, ends rounded, not two-pointed; white tubercles on spines and body quite prominent; a prominent transverse row on anterior and posterior edge of abdominal segments, and smaller ones scattered over the general surface;

spines, and transverse row of eight tubercles on anterior edge of first segment, and four on posterior and lateral edge of last segment, shining black; dorsal and stigmatal area, dark reddish brown, shading into the dull reddish of the subdorsal and substigmatal areas; venter dark brown, except narrow line at center, including thoracic feet and inner surfaces of prolegs; stigmata, large, velvety black, with narrow yellowish border.

Descriptions of pupæ: Female—Length, 35 mm.; width, 10 mm.; apical spine two-pronged, 3.5 mm. long; four prominent sharpened tubercles at the anterior extremity of body; extremities, and margins of the 5th, 6th and 7th segments armed with many sharp points; color, very dark reddish brown, almost black; general form as in *Anisota rubicunda.* Male—Length, 30 mm.; width, 8 to 9 mm.; apical spine, 3 mm.; other features similar to those of female.

Parasites: Immature larvæ were not infrequently found swollen posteriorly and attached to leaves or twigs by whitish silk. The swollen appearance was caused by the cocoon of an ichneumon parasite, spun within the body of the host larva. During the month of September, parasitic flies (½ to ¾ inch long, black, with red and white-marked limbs) escaped through circular openings cut near one extremity of the cocoon.



CALLIMORPHA SUFFUSA SMITH.

a, moth; *e*, pupa, side view, and tip of abdomen magnified; *d*, adult larva; *b* and *c*, middle segment of same from above, and from the side enlarged; *f*, egg, much magnified; figures *a*, *e*, and *d*, natural size, the others variously enlarged.

Early in April last, before the appearance of leaves, hairy lepidopterous larvæ ¾ inch long, of a general dark color, striped longitudinally with yellow and white, were noted in moderate numbers crawling about the trunks and branches of ash trees on the Agricultural College farm. Later these larvæ were observed feeding, usually from the lower surface, on the young leaves of the ash.

A number collected May 1st completed larval growth May 17th, attaining a length of 1⅛ inches, and formed slight silken cocoons, exteriorly covered with particles of earth, at the surface of the soil beneath leaves, etc., in breeding-cage.

Pupæ were found May 31, from which the above-named moth was obtained June 27.

In June and July of the previous year, large numbers of these handsome insects were collected from the grass and weeds about and in the grove in question. A visit to the grove July 1, '88, was rewarded by the capture of but a single moth—a gravid female. This experience illustrates the often-observed fact in entomology, that the abundance of an insect in any locality one season is of little value in estimating the probable numbers for the next. Careful search at this time failed to show either eggs or larvæ on the trees or grass in the vicinity. From the moth captured, about 100 yellowish spherical eggs in two closely-placed, but not crowded masses, were

obtained July 2d and 3d. Young larvæ appeared July 9th, and were supp[lied] ash leaves and grass, but soon died.

In the hope of finding half-grown larvæ, the grove was visited Oc[t.] three larvæ were found, after considerable search, feeding on the still hanging to some sprouts from the base of a few trees. A mist the time, moistened the leaves so that they could be eaten by the little difficulty and apparent relish. The larvæ were 10–12 mm. long in motion, and had the form and characteristic markings of full-gro except in being somewhat lighter colored, and having the subdorsal lateral stripes grayish white—not tinged with orange.

It is probable from the above, that this insect is single-brooded— the larval stage; and that the ash is its ordinary food plant. The fact t *Eupatorium* sp. and *Solidago* sp., common in the grove, and the vari grasses thereabouts, were still more or less green, and yet untouche further evidence that the ash is the food plant of the young as well larva.

Egg: .75 mm. in diameter, nearly spherical, slightly flattened at b unaided eye the surface appears smooth and shining, but with careful f high power it is seen to be covered with raised lines forming a regu Color, amber yellow, faintly mottled with a lighter shade.

Young larva: Length, about 2 mm.; head broader than body, resinous a few hairs; eye spots, black; piliferous tubercles, thoracic shield, an plates on abdominal feet, resinous; hairs, one to each tubercle, light co ing the thickness of the body in length; tubercles on each of the thorac 10, arranged in one transverse row, on abdominal segments except last, i 6 in anterior, and 4 in posterior row.

Mature larva: Length, 25–28 mm.; head somewhat less in diameter than the first thoracic segment, slightly bilobed, shining black, armed with a considerable number of black hairs; body, uniformly cylindrical, black, marked along the center of the dorsum by an orange stripe lighter colored between segments; a similar stripe, interrupted with black, covers the area just above and partly including the stigmata; a narrow, whitish-yellow line occurs midway of the dorsal and stigmatal orange stripe; and a similar line, curving down on the segments, borders the lower edge of the sides; area below the bordering lateral stripe, including the thoracic, and all but the inner surface of the abdominal feet, black, marked on each of the abdominal segments with an oblique yellowish spot; ventral surface within thoracic and abdominal feet, ashy, finely dotted with dark; segments armed with transverse rows of shining blue-black tubercles, which are covered with short, radiating hairs, both black and white, the black predominating on the dorsal, and the white on the lateral tubercles; stigmata, black.

Pupa: 15x5.5 mm.; dark reddish brown, robust, considerably enlarged back of the thoracic segments; last segment terminating in a produced semi-circular edge, slightly notched at the center, and armed with short, more or less forked hairs; wing-cases extend nearly to the posterior margin of the fourth segment; stigmata elongate, slightly elevated; general surface shining, abdominal segments minutely and sparsely punctured.

OBSERVATIONS ON THE DIVINING-ROD.

BY EDWARD A. KILIAN, ALMA.

To the unprejudiced, without doubt it must be a fact that "water-witching," as it is popularly called, is either a self-deception or an intentional fraud by those

claiming to have the power to divine underground water near the surface by means of a forked stick. That all who pretend to have this power of divination are intentional deceivers, I have always doubted. Ever before seeing "water-witching" performed, I had been of the opinion that there must be, as Prof. Czermak calls it in his lectures on *hypnotism*, "a not *well or not clearly-observed fact.*" In vain I sought for an explanation of the phenomenon. Works treating on the solution of popular superstitions did not give the least explanation. Mayo, in "Truth in Popular Superstitions, Divining-Rod and Witchcraft," comes to no solution of the problem; he experiments with the rod, but does not find the real cause. An article in a number of the St. Louis *Globe-Democrat* in March, 1888, on "Divination," does not solve it, in spite of all endeavors to do so.

Whether anyone else has made the observations herein stated, I do not know. They were made by a friend of mine, Werner A. Stille, Ph. D., Principal of the Baden Schools, Baden, St. Louis, Mo., and myself.

I saw "water-witching" performed for the first time some ten years ago, by an old honest farmer, who believed in it as gospel truth. Walking by the side of the performer, it became at once clear to me that there was a case of self-deception.

It may be hardly necessary to give a description of the divining-rod. The forked hazel or the forked twig of a peach tree are in high esteem by those who practice "water-witching," although any other forked twig will do. Both prongs of the rod have to be thin, of nearly equal thickness, and about two feet in length. An end is taken in each hand, the arms extended forward, and held stiff; the hands are kept at about the height of the hips, and turned outward, so that the closed fingers are above and the thumbs at the outside of the hands; the rod is grasped tightly and held horizontally, while walking over the ground to be explored for water.

Both arms and hands thus in a strained position are to regain a more easy position, but the rod must be held tightly. As the turning of the arms and hands is either by relaxation of the muscles or involuntarily, an invisible power seems to be active in twisting the rod out of the operator's hands. In the endeavor of the muscles to regain their natural position, the hands turn somewhat, and by observing them closely it will be seen that by this involuntary movement of the hands, caused by the relaxation of the muscles, the rod is bent downward, and in some instances with so great a force that it is twisted in the hand, and one or the other end will break.

And surely water will be found if "water-witching" is exercised in places where underground water near the surface is in abundance.

Try the experiment, which is easy to perform, and you have a very fine illustration of a "not well or not clearly observed fact."

METEOROLOGICAL SUMMARY FOR THE YEARS 1887 AND 1888.

PREPARED BY PROF. F. H. SNOW, UNIVERSITY OF KANSAS, FROM OBSERVATIONS TAKEN AT LAWRENCE.

1887.

The year 1887 was marked by a cold winter and a warm spring, while the summer and autumn were of nearly the average temperatures. The total rainfall fell but little short of the average amount, but its distribution was unfavorable to corn and other midsummer crops. A serious deficiency in July found the ground nearly destitute of moisture, on account of the eleven-inch deficiency of the year 1886, and in less than two weeks what promised to be the most abundant corn crop ever produced

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In the hope of finding half-grown larvæ, the grove was visited October 21st, and three larvæ were found, after considerable search, feeding on the few dead leaves still hanging to some sprouts from the base of a few trees. A misty rain falling at the time, moistened the leaves so that they could be eaten by the caterpillars with little difficulty and apparent relish. The larvæ were 10–12 mm. long when extended in motion, and had the form and characteristic markings of full-grown specimens, except in being somewhat lighter colored, and having the subdorsal and terminal lateral stripes grayish white—not tinged with orange.

It is probable from the above, that this insect is single-brooded—wintering in the larval stage; and that the ash is its ordinary food plant. The fact that the weeds, *Eupatorium* sp. and *Solidago* sp., common in the grove, and the various perennial grasses thereabouts, were still more or less green, and yet untouched by them, is further evidence that the ash is the food plant of the young as well as the adult larva.

Egg: .75 mm. in diameter, nearly spherical, slightly flattened at base. To the unaided eye the surface appears smooth and shining, but with careful focusing with high power it is seen to be covered with raised lines forming a regular hexagon. Color, amber yellow, faintly mottled with a lighter shade.

Young larva: Length, about 2 mm.; head broader than body, resinous, armed with a few hairs; eye spots, black; piliferous tubercles, thoracic shield, anal plate and plates on abdominal feet, resinous; hairs, one to each tubercle, light colored, equaling the thickness of the body in length; tubercles on each of the thoracic segments 10, arranged in one transverse row, on abdominal segments except last, in two rows, 6 in anterior, and 4 in posterior row.

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in the State was reduced to very small proportions. The abundant crops of oats, hay, potatoes and other spring and autumn products gave the State of Kansas a great advantage over some other States, which suffered from a more serious drouth, without similar compensations.

Other characteristics of the year were, the small percentage of cloudiness, the moderate wind-velocity, and the astonishingly low barometer of February 3d (the lowest barometric reading on our twenty-years record).

TEMPERATURE.

Mean temperature of the year, 53.12°, which is .20° above the mean of the nineteen preceding years. The highest temperature was 102°, on July 17th; the lowest was 20° below zero, on the 10th of January, giving a range of 122°. Mean, at 7 A. M., 47.56°; at 2 P. M., 61.87°; at 9 P. M., 51.52°.

Mean temperature of the winter months, 26.35°, which is 2.56° below the average winter temperature; of the spring, 56.32°, which is 2.67° above the average; of the summer, 75.77°, which is .11° below the average; of the autumn, 54.04°, which is .09° above the average.

The warmest month of the year was July, with mean temperature 79.79°; the warmest week was July 11th to 17th, mean 86.75°; the warmest day was July 17th, mean 89.50°. The mercury reached or exceeded 90° on 40 days, (just the average number,) viz.: one in May, 5 in June, 18 in July, 10 in August, and 6 in September. There was only one day on which the temperature reached 100°—July 17th.

The coldest month was January, with mean temperature 20.48°; the coldest week was January 1st to 7th, mean 4.36° above zero; the coldest day was January 8th, mean 7.13° below zero. The mercury fell below zero on 16 days, of which 9 were in January, 3 in February, and 4 in December.

The last hoar frost of spring was on April 24th; the first hoar frost of autumn was on October 12th; giving an interval of 171 days, or nearly six months, entirely without frost. This is 16 days longer than the average interval.

The last severe frost of spring was on April 4th; the first severe frost of autumn was on the 24th of October; giving an interval of 203 days, or nearly 7 months, without severe frost. The average interval is 198 days. No frosts during spring and autumn caused damage to crops of grain and fruit; but the low temperatures of January were seriously destructive to the buds of budded varieties of peaches.

RAIN.

The entire rainfall, including melted snow, was 33.84 inches, which is only .86 inch below the annual average. Either rain or snow, or both, in measurable quantities, fell on 91 days—13 less than the average. On 16 other days rain or snow fell in quantity too small for measurement.

The number of thunder showers was 23. There was but one light hail storm during the year.

SNOW.

The entire depth of snow was 25 inches, which is 3.15 inches above the average.

Of this amount, 9 inches fell in January, 6 inches in February, 6 inches in March, one inch in November, and 3 inches in December. Snow fell on 28 days, on 7 of which the quantity was too small for measurement. The last snow of spring was on April 22d. The first snow of autumn was on November 23d—15 days later than the average date.

FACE OF THE SKY.

The mean cloudiness of the year was 40.91 per cent., which is 3.46 per cent. below the average. The number of clear days (less than one-third cloudy) was 192; half-clear (from one to two-thirds cloudy), 86; cloudy (more than two-thirds), 87. There

were 73 days on which the cloudiness reached or exceeded 80 per cent. There were 58 entirely clear and 42 entirely cloudy days. The clearest month was October, with a mean of 24.09 per cent.; the cloudiest month was February, mean 57.86 per cent. The percentage of cloudiness at 7 A. M. was 44.45; at 2 P. M., 45.45; at 9 P. M., 32.84.

DIRECTION OF THE WIND.

During the year, (three observations daily,) the wind was from the S. W. 297 times, N. W. 240 times, S. E. 158 times, N. E. 136 times, N. 129 times, S. 64 times, E. 57 times, W. 14 times. The south winds (including southwest, south, and southeast) outnumbered the north (including northwest, north, and northeast) in the ratio of 519 to 505.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 132,367, which is 3,824 miles below the annual average for the preceding 14 years. This gives a mean daily velocity of 362.65 miles, and a mean hourly velocity of 15.11 miles. The highest velocity was 75 miles an hour, on July 21st; the highest daily velocity (the second highest on our record) was 1,150 miles, on the 20th of December; the highest monthly velocity was 14,680 miles, in January. The windiest months were January, March, April, and October; the calmest months were June, July, August, and September. The average velocity at 7 A. M. was 13.42 miles; at 2 P. M., 16.61 miles; at 9 P. M., 14.16 miles.

BAROMETER.

Mean height of barometer column, 29,109 inches, which is .002 inch above the annual average. Mean, at 7 A. M., 29.131 inches; at 2 P. M., 29.087 inches; at 9 P. M., 29.108 inches; maximum, 29.792 inches, on February 3d; minimum, 28.152 inches, on February 17th; yearly range, 1.640 inches. The highest monthly mean was 29.205 inches, in February; the lowest was 29.041 inches, in June. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 69.8; at 7 A. M., 79.6; at 2 P. M., 54.7; at 9 P. M., 75.1. The dampest month was February, with mean humidity 82.6; the dryest month was April, mean humidity 61.1. There were 13 fogs during the year. The lowest humidity for any single observation was 8 per cent., on March 8th.

1888.

The chief meteorological feature of the year 1888, at this station, representing the eastern portion of Kansas, was the abundant and well-distributed rainfall. The total precipitation came within one one-hundredth of an inch of the maximum rainfall of the year 1876, and has nearly made good the deficiencies of the years 1886 and 1887.

In temperature the annual mean was below the average. This result was chiefly due to the abnormal coldness of January, March, August and October, which more than overbalanced the unusually high temperatures of April, May, July, and December. Other peculiarities of the year were the low wind-velocity, the small proportion of cloudiness, and the unusually high barometric pressure. The year 1888 was the fifth successive year of wind-deficiency. Our records of the wind show four alternating periods: Four years of excess (1873–1876); three years of deficiency (1877–1879); four years of excess (1880–1883); and five years of deficiency (1884–1888).

TEMPERATURE.

Mean temperature of the year, 52.28°, which is .65° below the mean of the 20 preceding years. The highest temperature was 99°, on August 2d; the lowest was 18°

below zero, on the 15th of January; giving a range of 117°. Mean, at 7 A. M., 46.91°; at 2 P. M., 60.79°; at 9 P. M., 50.71°.

Mean temperature of the winter months, 28.41°, which is .37° below the average winter temperature; of the spring, 52.75°, which is 1.03° below the average; of the summer, 75.18°, which is .59° below the average; of the autumn, 52.77°, which is 1.27° below the average.

The warmest month of the year was July, with mean temperature 79.52°; the warmest week was July 28th to August 3d, mean 83.77°; the warmest day was August 2d, mean 87.125°. The mercury reached or exceeded 90° on 28 days, (12 below the average number,) viz.: six in June, 17 in July, 3 in August, and 2 in September. The temperature at no time reached 100°.

The coldest month was January, with mean temperature 17.70°; the coldest week was January 14th to 20th, mean temperature 3.33°; the coldest day was January 15th, mean 11.25° below zero. The mercury fell below zero on 9 days, of which 8 were in January and 1 in February.

The last hoar frost of spring was on May 19th; the first hoar frost of autumn was on September 28th; giving an interval of 132 days, or nearly 5 months, entirely without frost. This is 24 days shorter than the average interval.

The last severe frost of spring was on April 29th; the first severe frost of autumn was on November 9th; giving an interval of 203 days, or nearly 7 months, without severe frost. The average interval is 198 days. No frosts during spring and autumn caused damage to crops of grain and fruit; but the low temperatures of January were generally destructive to peaches and cherries.

RAIN.

The entire rainfall, including melted snow, was 44.17 inches, which is 9.51 inches above the annual average. Either rain or snow, or both, in measurable quantities, fell on 83 days — 20 less than the average. On 17 other days rain or snow fell in quantity too small for measurement.

The number of thunder showers was 37. There were five light hail storms during the year — two in May, two in August, and one in October.

SNOW.

The entire depth of snow was 22 inches, which is exactly the yearly average. Of this amount, 3 inches fell in January, 2 inches in February, 2 inches in March, 12 inches in November, and 3 inches in December. Snow fell on 25 days, on 10 of which the quantity was too small for measurement. The last snow of spring was on March 27th. The first snow of autumn was on November 9th, which is just the average date.

FACE OF THE SKY.

The mean cloudiness of the year was 42.49 per cent., which is 1.71 per cent. below the average. The number of clear days (less than one-third cloudy) was 179; half-clear (from one to two-thirds cloudy), 95; cloudy (more than two-thirds), 92. There were 78 days on which the cloudiness reached or exceeded 80 per cent. There were 61 entirely clear and 42 entirely cloudy days. The clearest month was September, with a mean of 22.44 per cent.; the cloudiest month was March, mean 53.87 per cent. The percentage of cloudiness at 7 A. M. was 48.77; at 2 P. M., 44.71; at 9 P. M., 34.

DIRECTION OF THE WIND.

During the year, (three observations daily,) the wind was from the S. W. 316 times, N. W. 201 times, S. E. 205 times, N. E. 135 times, N. 101 times, E. 73 times, S. 56 times, W. 11 times. The south winds (including southwest, south aud southeast)

outnumbered the north (including northwest, north and northeast) in the ratio of 577 to 437.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 128,185, which is 7,751 miles below the annual average for the preceding 15 years. This gives a mean daily velocity of 350.23 miles, and a mean hourly velocity of 14.59 miles. The highest velocity (the highest ever recorded at this station) was 96 miles an hour, from 2:25 to 2:30 A. M. on August 12th; the highest daily velocity was 930 miles, on the 25th of February; the highest monthly velocity was 13,830 miles, in March. The windiest months were January, February, March, and April; the calmest months were July, August, and September. The average velocity at 7 A. M. was 13.35 miles; at 2 P. M., 16 miles; at 9 P. M., 14.58 miles.

BAROMETER.

Mean height of barometer column, 29.132 inches, which is .25 inch above the annual average. Mean, at 7 A. M., 29.149 inches; at 2 P. M., 29.114 inches; at 9 P. M., 29.131 inches; maximum, 29.983 inches, on January 15th; minimum, 28.495 inches, on March 19th; yearly range, 1.488 inches. The highest monthly mean was 29.334 inches, in January; the lowest was 28.958 inches, in May. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 72.2; at 7 A. M., 81; at 2 P. M., 58.2; at 9 P. M., 77.3. The dampest month was January, with mean humidity 85.9; the dryest month was April, mean humidity 61.8. There were 15 fogs during the year. The lowest humidity for any single observation was 18 per cent., on April 22d and May 14th.

The following tables give the mean temperature, the extremes of temperature, the number of inches of rain and snow, the number of rainy days, the number of thunder showers, the mean cloudiness, the relative humidity, the number of fogs, the velocity of the wind, the mean and extreme barometer heights for each month of the year 1888, and a comparison with each of the preceding 20 years:

YEAR 1888.

Month.	Mean temp....	Max. temp.....	Min. temp.....	Rain (inches)	Snow (inches)	Rainy days...	Thun. storms.	Mean cloudiness.....	Humidity.....	No. of fogs.....	Miles of wind.	Mean barometer.....	Maximum barometer...	Minimum barometer...
Jan.....	17.70	54.0	-18.0	0.93	3	5	1	41.29	85.9	4	12,435	29.334	29.983	28.641
Feb.....	32.74	57.0	-1.0	1.27	2	7	0	50.68	78.2	6	12,250	29.143	29.851	28.621
March.....	38.63	78.0	14.0	5.47	2	10	4	53.87	78.0	0	13,830	29.140	29.696	28.495
April.....	57.55	88.0	31.0	2.58	0	5	1	37.00	61.8	0	12,860	29.172	29.658	22.693
May.....	62.08	83.0	38.0	1.97	0	8	5	47.09	65.3	0	10,956	28.958	29.302	28.621
June.....	73.10	94.0	52.0	8.31	0	12	11	45.22	70.2	0	10,380	28.976	29.269	28.713
July.....	79.52	97.0	62.0	4.28	0	7	7	32.10	71.1	0	7,160	29.104	29.300	28.950
Aug.....	72.91	99.0	52.0	9.07	0	12	6	48.81	79.6	2	7,841	29.100	29.470	28.825
Sept.....	66.04	91.0	39.0	0.23	0	1	0	22.44	65.7	1	8,043	29.170	29.603	28.970
Oct.....	53.07	85.0	32.0	3.74	0	4	2	39.46	66.6	1	11,160	29.078	29.370	28.738
Nov.....	39.20	79.0	21.0	4.54	12	6	0	50.67	74.5	1	9,520	29.223	29.642	28.809
Dec.....	34.78	60.0	7.0	1.78	3	6	0	41.29	74.4	0	11,750	29.185	29.598	28.564
Mean....	52.28	80.4	27.4	36.8	2	7	3	42.49	72.2	1	10,682	29.132	29.562	28.720

TWENTY-ONE YEARS—1868-1888.

Year.	Mean temp....	Max. temp....	Min. temp.....	Hot days (above 90°)..	Zero days.....	Days between severe frosts	Rain (inches)	Snow (inches)	Rainy days....	Thun. storms.	Mean cloudiness.....	Humidity.....	No. of fogs....	Miles of wind.	Mean barometer.....
1868...	52.77	101.0	-16.5	43	7	160	37.48	27.50	77	.....	42.35	.....	.....	.....	.....
1869...	50.51	96.0	-5.0	23	2	167	38.51	18.00	105	33	49.23	78.2	19	.....	29.108
1870...	53.70	102.0	-10.0	51	6	197	31.32	9.50	100	27	47.88	68.4	13	.....	29.097
1871...	53.56	103.0	-6.0	48	8	218	33.23	29.75	120	24	47.37	65.9	6	.....	29.076
1872...	51.30	97.0	-18.0	45	16	192	32.63	23.25	116	40	44.33	64.4	11	.....	29.112
1873...	51.96	104.0	-26.0	48	9	165	32.94	26.50	101	17	42.46	64.0	6	154,508	29.093
1874...	53.68	108.0	-3.0	58	2	187	28.87	43.00	99	20	45.54	65.7	14	145,865	29.121
1875...	50.60	99.0	-16.5	32	12	196	28.87	5.00	106	21	44.81	66.7	5	145,316	29.102
1876...	52.76	98.0	-5.0	36	4	179	44.18	25.75	102	29	41.27	66.8	4	148,120	29.102
1877...	54.16	99.0	-9.0	20	3	217	41.09	15.50	126	39	47.12	72.6	11	113,967	29.117
1878...	55.33	98.0	-6.0	35	7	228	38.39	25.50	107	38	40.65	70.2	5	125,793	29.067
1879...	54.67	99.5	-16.0	48	13	203	32.68	10.35	90	36	40.01	67.1	10	124,768	29.127
1880...	54.01	101.0	-12.0	41	2	211	32.65	7.00	89	29	40.15	67.9	18	146,039	29.123
1881...	54.65	104.0	-8.0	68	6	210	33.27	32.50	110	31	47.42	70.1	11	141,430	29.103
1882...	54.94	105.0	-6.5	40	1	232	27.60	18.00	102	26	45.41	68.6	14	137,736	29.113
1883...	51.66	96.5	-14.0	26	8	217	40.65	12.50	106	32	45.24	69.7	18	141,164	29.135
1884...	51.30	98.0	-21.5	20	14	198	43.45	29.00	105	35	47.56	72.6	28	131,188	29.111
1885...	51.01	96.0	-14.5	27	21	176	36.97	33.00	103	31	44.57	71.3	9	123,013	29.107
1886...	52.96	105.0	-18.0	53	16	203	24.25	23.50	103	28	39.64	66.5	5	127,769	29.111
1887...	53.12	102.0	-20.0	40	16	203	33.84	25.00	91	23	40.91	69.8	13	132,367	29.109
1888...	52.28	99.0	-18.0	28	9	203	44.17	22.00	83	37	42.49	72.2	15	128,185	29.132
Mean	52.25	100.5	-12.9	40	9	198	35.10	22.00	102	29	44.12	69.0	12	135,432	29.108

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